POWER and THE ENGINEER

EVERYTHING ABOUT THE GENERATION AND TRANSMISSION OF POWER

Vol. 32 NEW YORK, FEBRUARY 22, 1910 No. 8

THE turbine has come to stay; that is, to stay as long as engines will be used to transform the energy of expanding steam into heat, light and power.

Whenever and wherever a turbine is installed it will be placed in the hands of an operating engineer; and it is up to him to understand its construction, erection and operation; what it will do and what it will not do and what may and what may not be done with it.

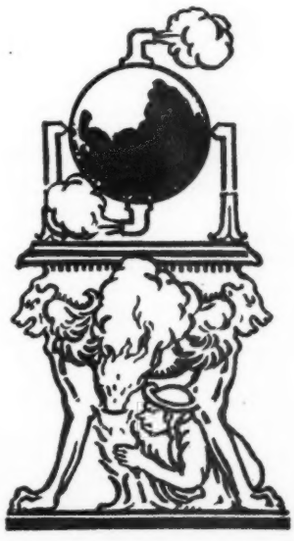
To know these things is not beyond the operative engineer, and when he takes the same interest in the turbine that he does in the engine he will be just as successful with it.

It is fairly well known that the turbine is not new. It is, so far as is known, the oldest of prime movers.

Two thousand years ago a reaction turbine was described as one of the "inventions of the ancients." In one form or another the turbine has been reinvented several times since.

In 1543 De Garay drove a steamboat by means of an impulse turbine some three miles an hour. About thirty-three years later a reaction turbine supplanted the dog that furnished the motive power for spit turning in the roasting of meats.

Then nearly a century later an Italian physician devised an impulse steam turbine which furnished power for the grinding of drugs and medicines.



One of the first patents granted by the Government of the United States on steam machinery was for an impulse wheel which through a chain of gearing, turned a roasting spit.

And interesting tales have been told of a locomotive driven at a high rate of speed by a reaction turbine.

The men who did things with the turbine in its several beginnings merely realized that there was a store of energy in the pent steam in the boiler. How much, they did not know, nor did they have any intelligent idea of the best methods by which it could be utilized.

But a few years ago the investigator began examinations of the flow of steam from one condition or pressure to another, and the influence of different-shaped passages on this flow was studied. From the tabulated results of these examinations the successful turbines have been designed and built.

It is a part of the engineer's work to care for and operate moving machinery, and as the turbine will be operated by engineers, no source of information about it should be neglected.

In this number appears the first of a series of articles on the turbine, written expressly for the engineer whose knowledge of mathematics may be limited, and who though handicapped by this lack, is anxious for technical knowledge that can be expressed in what he calls plain language.

Elementary Theory of the Steam Turbine

Simple Explanation of Impulse and Reaction Forces, and How These Forces Are Combined in Modern Turbines of Impulse and Reaction Types

BY WILLIAM E. SNOW

Modern steam turbines are divided into two general classes, known as the *impulse*, and the *reaction*, these terms relating to their methods of steam utilization.

In the ordinarily accepted meaning of the terms an impulse is a force acting in a forward direction, and a reaction

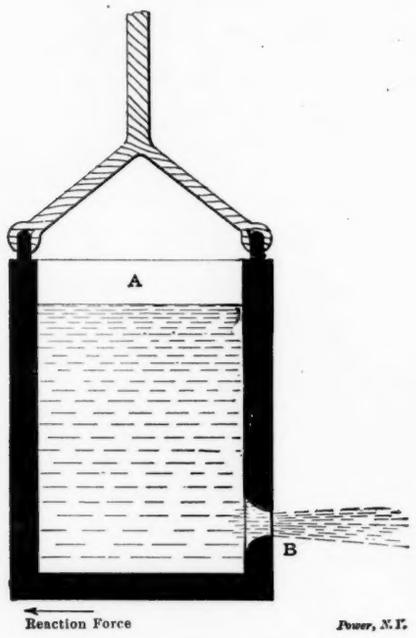


FIG. 1. SIMPLE REACTION

is a force acting in a backward direction —a resultant of the impulse, and equal to it in magnitude. These terms, however, as applied to steam turbines, are somewhat misleading, as in all impulse turbines the steam acts by impulse on entering and by reaction on leaving the buckets; while most so-called "reaction" turbines in reality operate by both reaction and impulse. In order to clearly understand the principal points of difference between the types, let us refer to the graphical illustrations given in Figs. 1, 2, 3 and 4.

Fig. 1 is an example of simple reaction. The vessel *A* is suspended from a cord and filled with water. The water escapes from the orifice or nozzle *B*, and as there is consequently no resistance at this point to the pressure of the fluid in the vessel, the unbalanced force exerted on the walls directly opposite *B* causes the vessel to move reactively in the direction of the arrow.

Hero's turbine, invented 120 B. C., shown in Fig. 5, is an excellent example of a purely reaction type. As will be seen, this consisted of the hollow metal globe *A*, mounted rotatively on the uprights *B B* by suitable pivots or bearings. This globe was provided with two bent tubes or nozzles *C C* pointing in tangentially opposite directions. Steam from the boiler *D* was conducted to the globe by one of the supports *B* which was made hollow for this purpose. The steam, issuing from the bent tubes or nozzles *C C*, caused the globe to rotate reactively in a direction opposite to that of the jets. The principle of operation of this turbine was identical with that of the ordinary lawn-sprinkler of the present day, whose rotating arms are

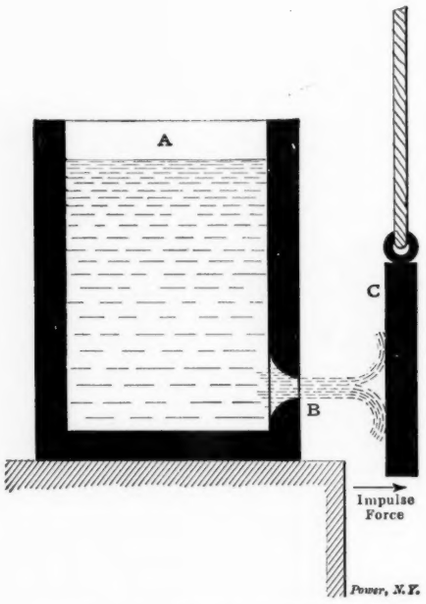


FIG. 2. SIMPLE IMPULSE

moved by the reaction of the water escaping from them.

Fig. 2 is an example of simple impulse. As in the previous case, the vessel *A* is filled with water, but instead of being suspended it is fixed immovably in place. The jet of water escaping from the orifice or nozzle *B* is made to impinge upon the flat plate *C*, suspended from a cord at a suitable hight. The pressure of the jet causes the plate *C* to move by impulse in the direction of the arrow. There will also be a reaction force exerted, equal in magnitude and opposite in direction to the impulse. The vessel being in this case fixed immovably, this reaction force does no work.

Branca's turbine, invented 1629 A. D., shown in Fig. 6, is an excellent example of a purely impulse type. As will be seen, this consisted of the wheel *A*, mounted rotatively on the support *B* by means of suitable bearings. This wheel was provided with paddles or buckets *C* similar to those used in waterwheels. A tube or nozzle *D* was placed close to the wheel, so that the issuing steam would impinge on the buckets *C*. Steam was supplied from the boiler *E*, and issuing from the nozzle *D* by its impulse caused the wheel to rotate in the direction of the impinging jet. It is interesting to note that, crude as the Hero and Branca turbines were, they clearly establish the two distinctive classes from which all modern turbines are derived.

In Fig. 3 is an example of the impulse and reaction forces exerted by the working fluid on the buckets of a modern turbine of the so-called "impulse" type. As in the previous case, the vessel *A* is filled with water and fixed immovably in place. In this case, however, the suspended plate *C*, instead of being flat is given a semi-circular form, approximately the shape of the buckets in an impulse turbine. The jet of water escaping from the orifice or nozzle *B* impinges upon this curved surface and is turned back upon itself through an angle of 180

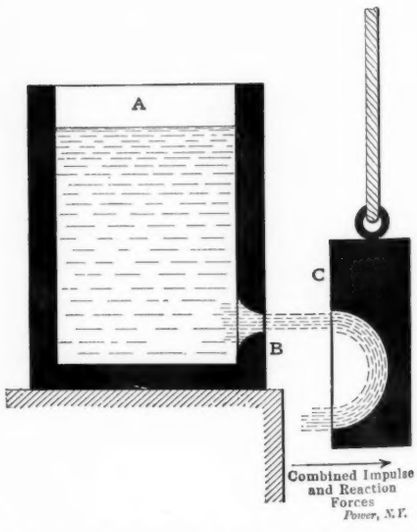


FIG. 3. PRINCIPLE OF MODERN IMPULSE TURBINE

degrees, issuing from the bucket in a direction opposite to that by which it entered. It is therefore evident that the jet acts by impulse on entering, and by reaction on leaving, the bucket. Since action and reaction are equal, neglecting friction, the combined impulse and reaction forces tending to move the plate *C*

in the direction of the arrow will be twice as great as the impulse force in the previous case, Fig. 2. This is the principle on which the buckets of all modern commercial turbines operate, whether of the impulse or of the reaction type.

In Fig. 4 is an example of the impulse and reaction forces exerted by the working fluid on the buckets of a modern turbine of the reaction type. As in the previous case, the vessel *A* is filled with water, but instead of being fixed immovably in place it is suspended from a cord, as in Fig. 1. The plate *C*, provided with a semi-circular bucket, is also suspended from a cord, as in Fig. 3. The jet of water escaping from the orifice or nozzle *B* impinges on the curved surface of the bucket, tending by its combined impulse

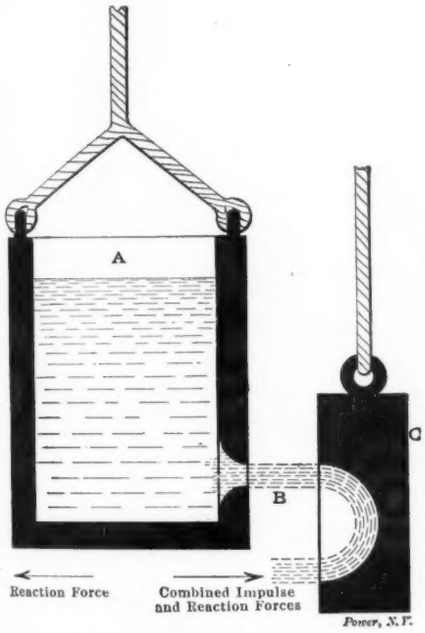


FIG. 4. PRINCIPLE OF MODERN REACTION TURBINE

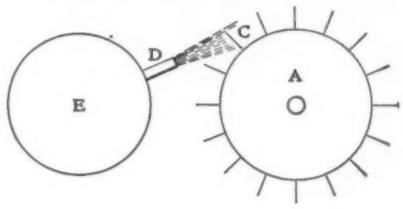
and reaction forces to move it in the direction of the arrow. In this case, however, the reaction force, equal in magnitude but opposite in direction to the impulse force, is free to move the vessel *A* in the direction of the second arrow. This is the principle on which modern commercial turbines of the reaction type operate.

It is easy to determine whether a turbine belongs in the impulse or the reaction class from the fact that in all impulse turbines the steam pressure is the same on both sides of any one row of buckets; in all reaction turbines there is a fall of the steam pressure in passing any one row of buckets, and the pressure on the two sides of the buckets is not equal. This will be seen more clearly by referring to Figs. 7 and 8.

Fig. 7 shows the bucket and nozzle arrangement of a turbine of the impulse class. In this drawing *B* is the nozzle, *C C* are the rotating buckets moving in the direction of the large arrows and *D* are the stationary buckets or reversing guide. The steam enters the nozzle *B* at boiler pressure, and is expanded completely in the nozzle right down to the back pressure of the exhaust, all its available pressure energy being thus converted into velocity energy. The steam, delivered in this form to the buckets, is incapable of any further expansion; consequently the pressure must be the same on both sides of any one row of buckets. This rule holds good, regardless of the number of stages that may be used.

The principle of operation of this type of turbine is shown by the small arrows, indicating the flow of the steam. The steam from the nozzle enters the first set of moving buckets at high velocity, but no appreciable pressure, and is turned through an arc of approximately 150 degrees, whereby a certain portion of its velocity is abstracted and converted into useful work. As the steam issues at greatly reduced velocity from this first set of moving buckets, it is caught by the stationary buckets or guide *D* and redirected at proper angle into the second set of moving buckets. Here it is again turned through an arc of 150 degrees, and most of its remaining velocity abstracted and turned into useful work.

Fig. 8 shows the arrangement of the stationary and the moving buckets of the turbine of the reaction type. The stationary buckets or guides *B B* correspond to the nozzles in the impulse type of turbine, and *C C* are the moving buckets similar in form to the stationary guides. The steam enters the first set of stationary buckets or guides *B* at boiler pressure. Owing to the nozzle-like form of these blades, the steam here undergoes a partial drop in pressure, with a corresponding expansion and increase in velocity. As the drop in pressure per stage in this type of turbine rarely exceeds 10 or 12 pounds, the velocity of the steam is not nearly as high as in the case of the greater expansion that occurs in the nozzle of the impulse turbine. The steam issues at moderate velocity, and but slightly reduced pressure, from the guides *B* and impinges upon the first set of moving buckets *C*, imparting to them by impulse that portion of its pressure energy that has been converted into velocity by its passage



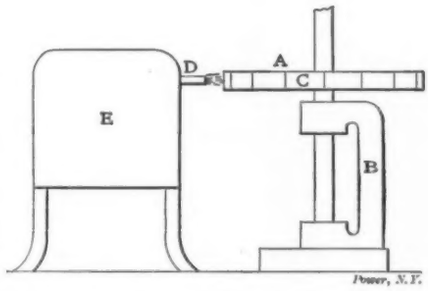


FIG. 6. BRANCA'S IMPULSE TURBINE

through the guides *B*. Owing to the shape of the moving buckets, which have the same nozzle-like form as the guides, the steam undergoes a still further pressure drop, with a corresponding expansion and increase in velocity in its passage through. As a result of this increase in velocity, the issuing steam imparts to the buckets by reaction a portion of the pressure energy that has been converted into velocity by its passage through. This same process is repeated in the second set of stationary guides and moving buckets, and so on throughout as many stages as are required to abstract all the available energy from the steam.

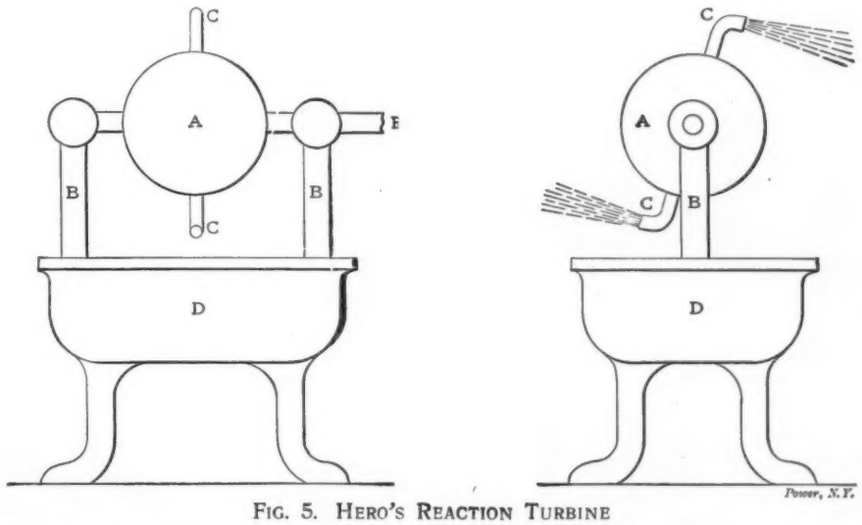
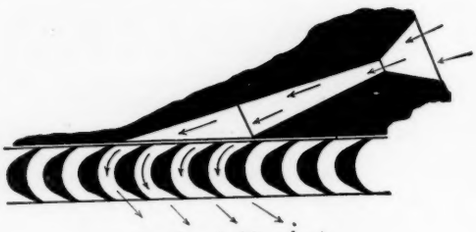
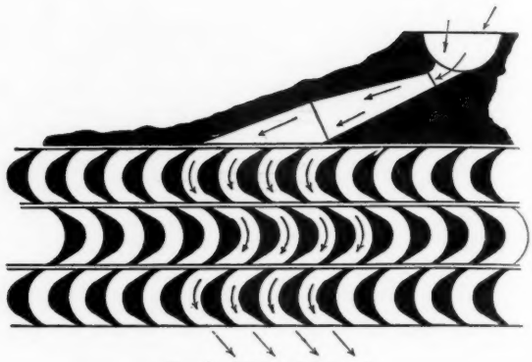


FIG. 5. HERO'S REACTION TURBINE

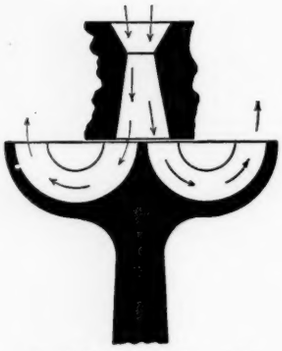
It will be noted that the pressure in each successive clearance space between the stationary and moving buckets is



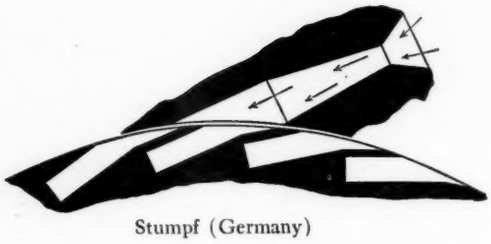
De Laval (Sweden)



Curtis (United States)

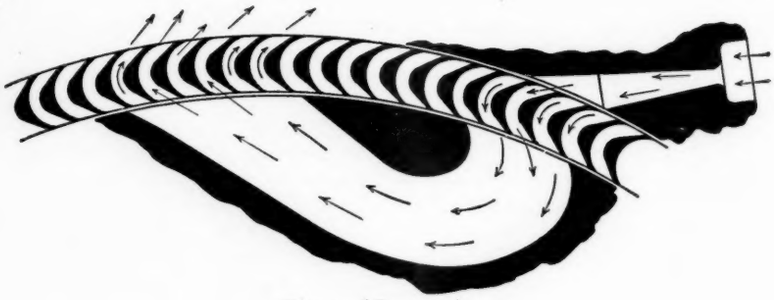


Double Bucket Stumpf



Stumpf (Germany)

Single Bucket Stumpf

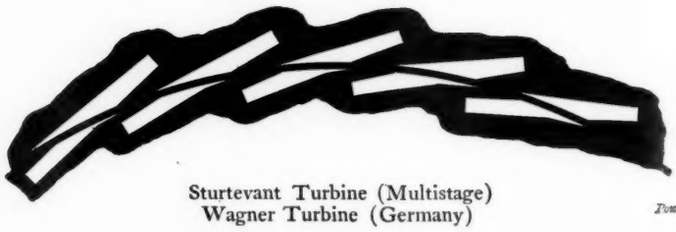


Electra (Germany)

Kerr Turbine (United States) - Maardt Turbine (Germany)

Kerr

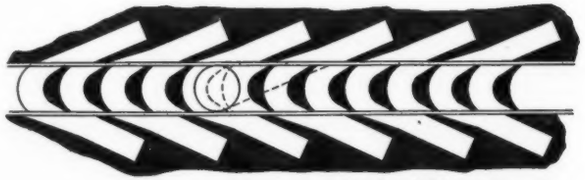
Sturtevant



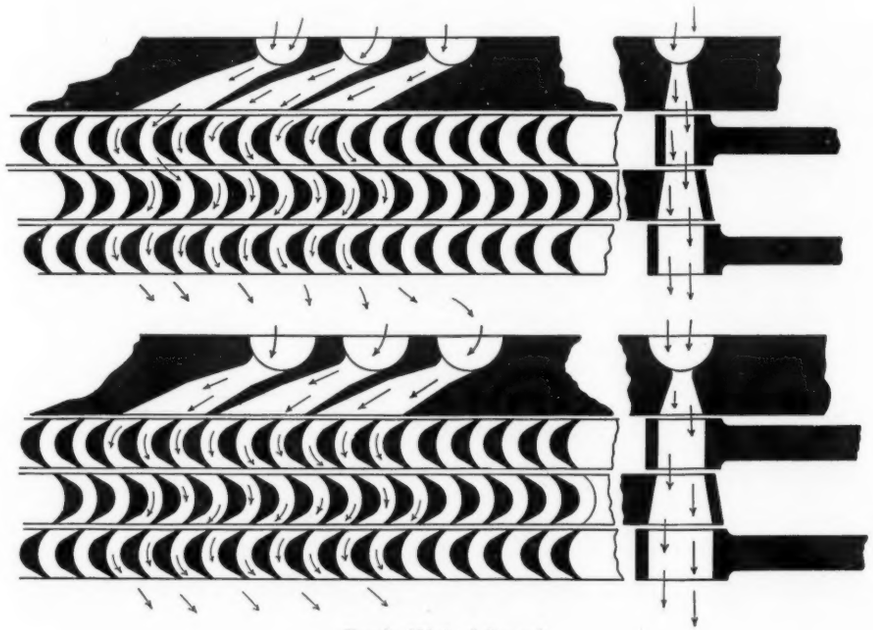
Sturtevant Turbine (Multistage)
Wagner Turbine (Germany)

Power

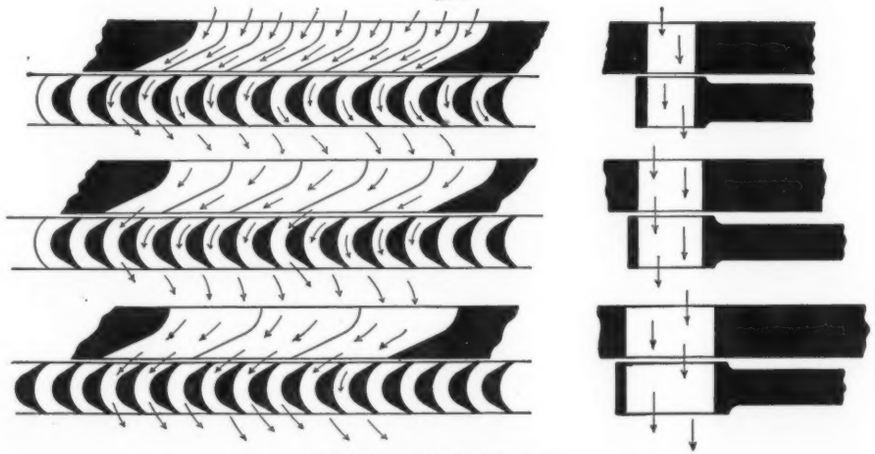
Terry (United States)
Sturtevant (United States)
Bliss (United States)



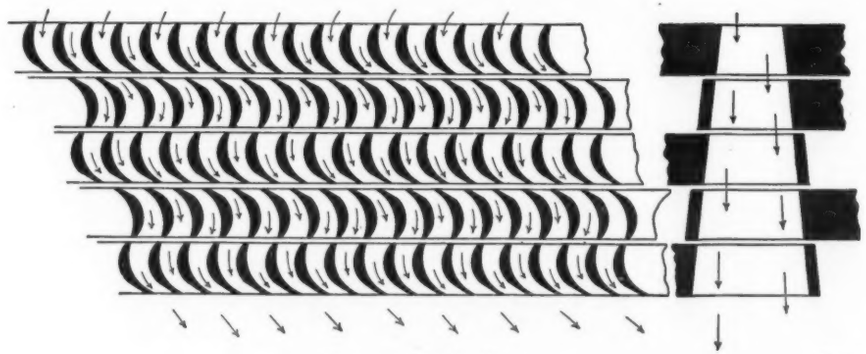
Drake (United States)
Wagner (Germany)
Single Stage Turbines - Impulse Type



Curtis (United States)
Multistage Turbines - Impulse Type



Wilkinson (United States)
Rateau (France)
Zoelly (Switzerland)
Multistage Turbines - Impulse Type



Parsons (England)
Allis - Chalmers (United States)
Multistage Turbines - Reaction Type

lower than in the preceding one. Thus, the pressure at *E* is lower than at *D*, the pressure at *F* is lower than at *E*, the pressure at *G* is lower than at *F*, etc.

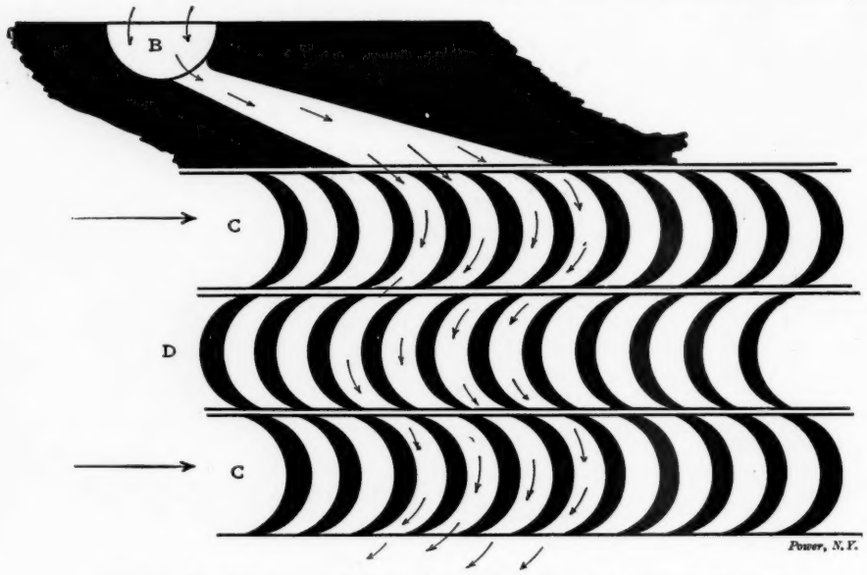


FIG. 7. BUCKETS AND NOZZLE ARRANGEMENT OF IMPULSE TURBINE

From the preceding the following rule is derived for the proper classification of all turbines:

Impulse Turbines—Equal pressure on the two sides of any one row of buckets.

Reaction Turbines—Fall of pressure in passing any one row of buckets.

While the principle of operation of all commercial turbines of the reaction class is practically the same, impulse turbines can be subdivided into several different types, according to their particular method of steam utilization, as follows:

IMPULSE TYPES

Single-Stage Type—Turbines with but one set of nozzles and one row of moving buckets.

Velocity Compounded—Turbines with one set of nozzles only, but with two or more rows of moving buckets, with intermediate guides.

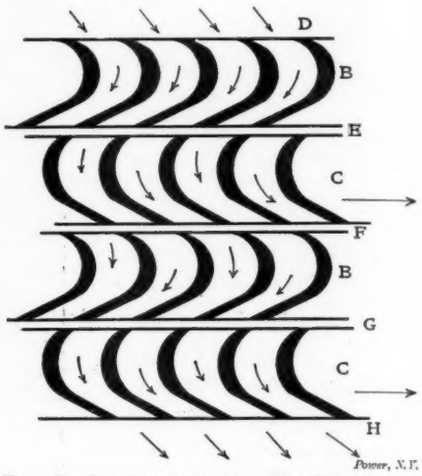


FIG. 8. STATIONARY AND MOVING BUCKETS IN REACTION TURBINE

Pressure Compounded—Turbines with two or more stages, each stage comprising one set of nozzles and one row of moving buckets.

Pressure and Velocity Compounded—Turbines with two or more pressure stages, each pressure stage comprising one set of nozzles and two or more rows of moving buckets, with intermediate guides.

Oil Data on Various Types of Engine

BY F. E. SPERRY

The following data deal with the amount of cylinder oil used on different types of power-plant machinery, and were obtained, partly through observation on the part of the writer, and partly from the engineers in charge of various plants. The table gives a list of the data, while the engines are referred to by numbers, as explained by the following:

Engines Nos. 1, 2, 4, 5, are installed in a manufacturing power plant; engine No. 3 is a small engine used in connection with a small isolated power plant; engines Nos. 6 and 7 are installed in another power plant and engines Nos. 8, 9 and 10 are machines installed in a waterworks plant.

No. 1 is a Corliss engine, operated noncondensing, part of the load being taken off by means of a rope drive, and part by a direct-current generator, which is belt driven. No. 2 is a high-speed engine, operating noncondensing, and is direct connected to a 220-volt direct-current generator. This engine is of the simple slide-valve type, and has but one cylinder. No. 3 is an engine of moderately high speed, is operated noncondensing, and is also of the simple slide-valve type, having one cylinder.

No. 4 is a duplex steam compound air compressor. The steam cylinders of this machine are 12 inches in diameter, the high-pressure air cylinder is 12 inches in diameter, the low-pressure air cylinder is 18 inches in diameter, and the stroke is 18 inches. The compressor furnishes air at 100 pounds gage pressure, the average speed of the machine being 150 revolutions per minute.

No. 5 is a direct, double-acting steam pump, making an average of 40 strokes per minute. The pump takes the water from the feed-water heater and pumps it into the boiler, the boiler pressure being 100 pounds gage.

No. 6 is a compound, single-acting automatic engine, having a high-pressure cylinder 14 inches and a low-pressure cylinder 24 inches in diameter, stroke 14 inches. The speed is 270 revolutions

OIL DATA TABLE.

Engine No.	1	2	3	4	5	6	7	8	9	10
Size	Corliss 24x42 inches	High Speed 16x14 inches	Medium Speed 8x10 inches	Air Compressor 18x12x12 inches	Pump 8x10x10 inches	Single Acting 14x24x14 inches	High Speed 10x16x12 inches	Corliss 12x36 inches	Flywheel Pump 15x24x10½x18 inches	Air Compressor 10x10x12 inches
Revolutions per Minute	82	250	190	150	40-in. stroke	270	270	84	40	160
Steam pressure	100 lb.	100 lb.	80 lb.	100 lb.	100 lb.	150 lb.	150 lb.	100 lb.	100 lb.	100 lb.
Hours per day run	9	9	10	9	9	24	24	24	24	12
Days per month run	26	26	26	26	26			30	30	30
Price of oil per gallon	$0.35	$0.35	$0.50	$0.35	$0.35	cyl. $0.40 crank, $0.15	$0.40			$0.30
Oil used per day, gallons	0.125	0.125	0.125	0.25	0.062	cyl., 0.75 crank, 4.00	0.375	7.5 0.25	7.5 0.25	3.75 0.125
Oil used per month, gallons	3.25	3.25	3.25	6.50	1.62			7.5	7.5	3.75
Cost of oil per month	$1.14	$1.14	$1.63	$2.28	$0.57					$1.13
Load		20 kw.				160 h.p.	100 h.p.	50 h.p.	30 h.p.	

per minute. The oil consumption of this engine varies with the quality of oil used in the crank case. The cylinders are fitted with lubricators, but owing to the splash of the oil in the crank case less cylinder oil is required when a good grade of crank-case oil is used. The data in the table give the price and the amount of crank-case oil used along with the cylinder-oil data. The average load on the engine is 160 horsepower, the engine being direct connected to an alternating-current generator.

No. 7 is a compound, high-speed engine, having a 10-inch high-pressure cylinder, 16-inch low-pressure cylinder, and stroke of 12 inches; speed 270 revolutions per minute. This engine as well as No. 6 is run noncondensing, carrying a load of 100 horsepower.

No. 8 is a simple 12x36-inch Corliss engine, running at a speed of 84 revolutions per minute; the engine is run condensing, and drives a 220-volt, 50-kilowatt direct-current generator; it is also connected by belts to four deep-well power pumps. The average load of the engine is 50 horsepower.

No. 9 is a flywheel type of pump having duplex cylinders 15, 24 and 10¼-inch with an 18-inch stroke; double-acting water end and compound steam end. The cutoff of the engine is maintained at ⅜ stroke to carry the average load. The pump is operated condensing, speed 40 revolutions per minute, and the average head pumped against is 108 feet.

No. 10 is a 10 and 10 by 12-inch air compressor operating against an air pressure averaging 75 pounds gage. The compressor is run noncondensing at a speed of 160 revolutions per minute.

The hours which machines Nos. 6 and 7 are operated are dependent entirely upon quite variable conditions; consequently the oil consumption has been based on a 24-hour operation, and the oil used per month has not been computed for these engines on account of this condition. Both of these engines run noncondensing.

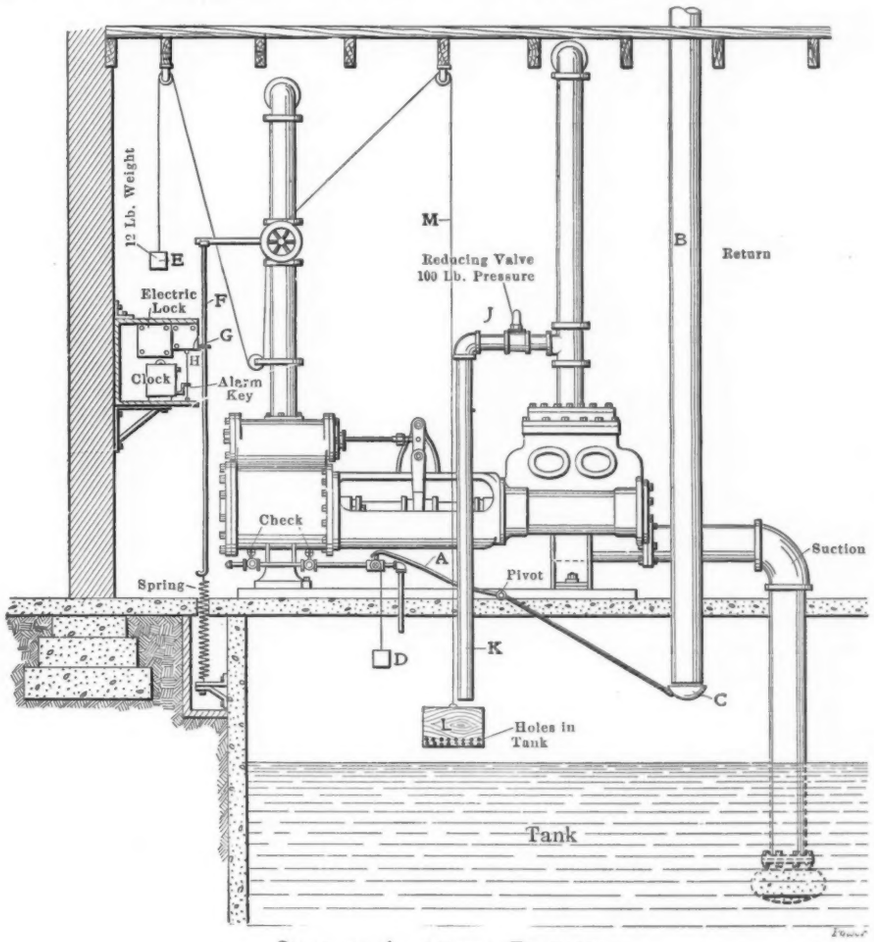
Automatic Control of a Duplex Pump

BY W. O. ROGERS

In establishments where the spinning of cotton yarn is carried on, the air must possess a certain amount of humidity in order to prevent the yarn from breaking and causing trouble. To furnish moisture to the air, water must be circulated through pipes to humidifiers stationed throughout the room, and naturally a means of regulating the water supply is necessary. In one case the engineer devised a homemade apparatus for automatically regulating the pump supplying the water to the system. In this instance it was found that the watchman either neglected to start the pump, or ran it too fast, or gave it no attention whatever.

The illustration gives a good idea of the manner in which the device was arranged. The pump, which is of the duplex type, is fitted with drip pipes, one from the end of each steam cylinder and all connected to the same main pipe. Each drip pipe is fitted with a check valve so that the steam from one end of the cylinder will not bypass to the other.

In order that the drips shall not be open continuously, a method of automatically closing them as soon as the pump had cleared itself of water was devised. This was arranged by means of a lever *A*, pivoted, as shown, to the planking on which the pump rested over the top of the reservoir. On the drip pipe, which extended part way toward the water end, and then dropped down to the water tank, was fitted a valve, on the wheel of which a pin was extended up, and bent at right angles to the wheel, so that the lever *A*, when brought down would engage the pin and be held in position by a notch on the end. Fitted to the valve wheel on the drip pipe was a cylinder on which was wound a cord, on the loose end of which hung a weight. As soon as the pump is started by the clock, which will be explained later, the drips having been left open by the engineer upon going away at night, water is circulated through the system throughout the building and returning through the pipe *B* strikes with considerable force the bell cup *C*, knocking it down to a lower position, which would raise the other end of the lever *A*, thus releasing the pin on the valve wheel, and allowing the weight *D* to close the drip valve, thus shutting off the escape of steam from the cylinders.



SHOWING AUTOMATIC FEATURES

The manner in which the pump was started was by means of a clock and an electric lock, which was used without the magnets. The clock was arranged with a lever extending from the alarm winding

key as shown, which in turning engaged the wire *H*, operating the lock mechanism, thus releasing the spring and causing it to unlock, the wire being held in position by an eye screw in the bottom of the box in which the lock and box are set.

On the steam pipe of the pump, the valve wheel was fitted with a cylinder to which a cord was connected and ran over a pulley secured to the roof. On the end of this cord a weight was hung in the tank, as at *L*. Another cord was attached to the same cylinder, extending up to the roof and over another pulley and sustaining a weight of 12 pounds, as shown at *E*. From the valve wheel of the throttle, an arm extended out, having a notch in the end, in which one end of the rod *F* engaged, the other end being secured to a spring which held the rod in place against the lip of the lock, as at *G*, the rod having a square projection at that point. When the clock reaches the hour for which it is set, say, 4 o'clock in the morning, the alarm winding key revolves, pressing the extending lever against the wire *H* which operates the lock, releasing the projection *G* and allowing the rod *F* to fall out of place. The weight *E* then opens the steam valve and starts the pump.

To provide against an overpressure, due to the pump working at too high a rate of speed, the release valve shown at *J* was attached to the delivery pipe of the system. When the pressure in the pipe and the system exceeded 100 pounds per square inch, the release valve operated allowing water to pass back to the tank through the pipe *K*, which, however, emptied into the box *L*, which is suspended to the cord *M* attached to the cylinder on the pump throttle valve. The box *L* has holes drilled in the bottom to allow the gradual escape of water. The operation is as follows: As the pressure in the system exceeds 100 pounds per square inch, the release valve allows the water to escape through it and the drain pipe *K* into the box *L*, which when the weight becomes sufficient, due to being partially full, overcomes the weight of *E* and therefore closes the throttle. The holes in the bottom of the box are to allow the water to gradually escape, because as the speed of the pump decreases, the pressure in the system also decreases, and when the water leaks out through the holes, the weight overcomes the weight of water in *L* and, therefore, opens the steam valve a trifle, thus keeping the regulation of the pump practically constant.

It is claimed by the designer that this system has worked most satisfactorily, and undoubtedly would be of advantage to others who are situated under similar circumstances.

Economical Velocities in Steam Piping

Factors Which Must Be Considered in Computing the Steam Velocity in Piping and Their Reduction to a Common Basis before Applying the Formulas or Curves

BY PERRY WEST

The foregoing discussion and curves, which appeared in the February 8 number, are based on an even rate of steam flow. Other conditions must be reduced to an equivalent of this even-flow condition before the formula and curves are applied.

Owing to the various conditions of service, some classes of high-pressure piping do not naturally afford an even flow of steam, nor is it always good practice to use the most economical velocity of flow regardless of other considerations. The following may be said in this respect regarding: (1) boiler leads, (2) engine leads, (3) and turbine leads.

Boiler Leads

For boiler leads, sizes are sometimes kept above the economical, due to the danger of priming with too high a velocity in the outlet. For boilers with attached superheaters the leads from the superheaters may be designed for the most economical velocity inasmuch as priming is impossible. The same is practically true if properly designed dry pipes are used. The best practice today is to allow a velocity of 4000 feet per minute in boiler leads when no special provisions exist against priming. This velocity is largely a matter of judgment, however, and experience must be relied upon in its determination. Broadly speaking, the velocity in boiler connections could no doubt be materially increased above present-day practice with the result that losses would be decreased and the system made more flexible against expansive strains. This matter of flexibility, depending as it does upon the connections to the fixed points, should have a very material bearing upon their sizes.

Engine Leads

Under this heading will be classed the supplies to all kinds of reciprocating steam-driven units. The leading peculiarity in figuring the sizes for these is due to an intermittent demand for steam in the cylinder. This causes an intermittent flow in the supply pipe, and in the headers themselves from which the supply pipes lead. In reasonable-sized stations, having several units, this effect in the headers may be neglected. In smaller plants it should be considered and allowances in header sizes be made. In the design of any station having several reciprocating units, the selection of speeds should be such that no two units will have commensurate numbers of revolutions. Otherwise two or more units may fall into step in such a way as to take steam together periodically, with the resulting bad effects in headers which are found in the engine leads themselves. Especially is this true of alternating-current electric generating units running in synchronism.

The disadvantage of the pulsating flow in engine leads is, that with the same quantity of steam per hour to be supplied through the same size pipe, a greater maximum velocity is necessary, with consequently more wire drawing and a greater drop of pressure.

This unevenness of flow in the case of a reciprocating unit, is not only that caused by the steam being admitted to the cylinder for a portion of the stroke only; but a further unevenness of flow during this period of admission itself is caused by variations in the speed of the piston. In other words, the volume cleared by the piston and subsequently occupied by the incoming steam has a variable rate of increase, this rate beginning at zero on the end of the stroke and increasing to a maximum near the center. Take for example an engine cutting off at one-quarter stroke, the maximum rate at which steam is taken at cutoff is not four times what it would be for continuous admission, but is increased to 7.256 times the average rate, due to the variable piston speed. This increase in velocity, if allowed to extend to the supply pipe, causes an increased drop in pressure through it, and coming as it does at or before cutoff, has considerable effect upon the economy of the engine. Receivers or receiver separators are generally installed in the supply pipe near the engine throttle, for relieving this situation, and are satisfactory and effective, if properly proportioned. Another function of the receiver is to relieve the system of shocks and strains which would otherwise be caused by the intermittent flow of the steam, and to afford an ample and ready supply of steam at the throttle at all

times. The elimination of vibrations of this character is of the utmost importance as far as the life and maintenance of piping is concerned. Its ill effects, such as crystallization and leaky joints, are well understood, however, and need no further comment here.

Let

U = Loss in B.t.u. per pound of steam transmitted by radiation from the receiver,

H = Loss in B.t.u. per pound of steam transmitted due to friction in the supply pipe,

p = Drop of pressure in the supply pipe,

P = Initial pressure, absolute,

V = Ratio of receiver volume to cylinder volume.

Then

$$p = \frac{3P}{16V}$$

nearly, for cutoff at one-quarter stroke, for if the engine is cutting off at one-quarter stroke, $1 \div 4\ V$ will represent the fraction of the whole receiver volume taken out during admission.

If the flow into the receiver is assumed constant, there will have been replaced in the same length of time

$$\frac{1}{4} \times \frac{1}{4V} = \frac{1}{16V}$$

of the total receiver volume. This will still leave the receiver minus $\frac{3}{16V}$ of its volume at cutoff, and since dry steam may be taken as a perfect gas,

$$p = \frac{3}{16V} \times P = \frac{3P}{16V},$$

from which

$$H = K\frac{3P}{16V}\ (nearly).$$

The fixed charges on the receiver may be reduced to its equivalent in B.t.u. per pound of steam transmitted and then be added to U plus H, and the size of receiver be selected which will make this sum of all charges against it a minimum.

Turbine Leads

Turbine leads differ from the reciprocating-unit leads in that the flow of steam is generally even. Some types of turbines are fitted with governing mechanism which admits steam to the turbines intermittently. In such cases the piping requirements are somewhat the same as for the reciprocating unit. The vibratory evils are practically the same. There is a difference as to steam velocities, however, which should be noted, i.e., admission is more nearly continuous than for an engine under similar conditions.

Headers and Mains

In estimating the sizes for headers and mains, it is generally safe enough to assume an even flow. None of the special conditions just cited for the other three classes of supply pipe need apply to mains. Some former practices have tended toward large sizes for headers, but this scheme is not generally followed today. The idea in using large headers was to have the additional capacity in piping perform some of the functions of a receiver separator, the lowering of velocity tending to separate entrained water, and the capacity acting as a receiver between the boilers and engines. Still another point was that water would not be so readily picked up and carried to the engine, thus eliminating a most important element of danger. Better practice along all these lines seems to be to design the headers and mains as carriers only, and to make proper allowance in the rest of the apparatus for taking care of the other features mentioned. Receivers placed near cylinder inlets are more effective and less wasteful of heat by radiation than is a large header.

Piping should be designed so as to drip clear of water pockets and allow for full velocity. With superheated steam at high pressure it is easier to keep the piping free of water than it formerly was with low-pressure saturated steam. As far as any separating action in the headers is concerned, it is better that this be left to the separators, where the facilities for draining the water away are better.

Experience of a Borrowing Engineer

An Engineer Who Had Formed the Habit and Borrowed Daily Anything from a Piece of Packing to an Indicator Does not Appreciate Such Accommodation from a Neighboring Plant

BY R. O. WARREN

The engine rooms of the W. H. Heath and J. W. North shoe factories stood side by side, with a fence intervening. When I ran the engine at the Heath plant it was a common thing to step over to the North engine room to see Redfield, the engineer, who was a most accommodating chap, with whom I was on excellent terms.

Finally I obtained a better job; an engineer by the name of Schiester took my place at Heath's. A few weeks ago I had a day off and so dropped in to see how things were going with Schiester, when he let out on Redfield in a manner most astonishing.

"It ain't a bit of use trying to please your neighbors," he began as soon as I asked him how he was getting on with his neighbor, Redfield. "I done my best to get on with that fellow, but he's a little off. I had not been here more than an hour when I thought I would be neighborly and show I was not stuck up, and as I was out of chewing tobacco I asked him for enough to last me until I could get some that night."

"Well, I always found Redfield friendly when I ran here," I replied.

"Oh, he's friendly enough, but he is a little too particular to suit me. When he took out his plug of tobacco he also took out his pocket knife and asked me to cut it off, as he did not like to have anyone bite tobacco from his plug.

"Redfield's got a telephone, you know, and as I was kind of sweet on a girl down at the laundry, I used to go over and use it a little. It was unlimited in calls and saved me a whole lot of nickels. He never had much to say, but one day when I asked him how he liked his 'phone,' he said he thought he would like it first rate if he ever got a chance to use it. I don't think he was very friendly about that, especially as I had only used it four times that forenoon."

"I don't think he meant anything by that," I replied, "for I always found him ready to lend anything within reach."

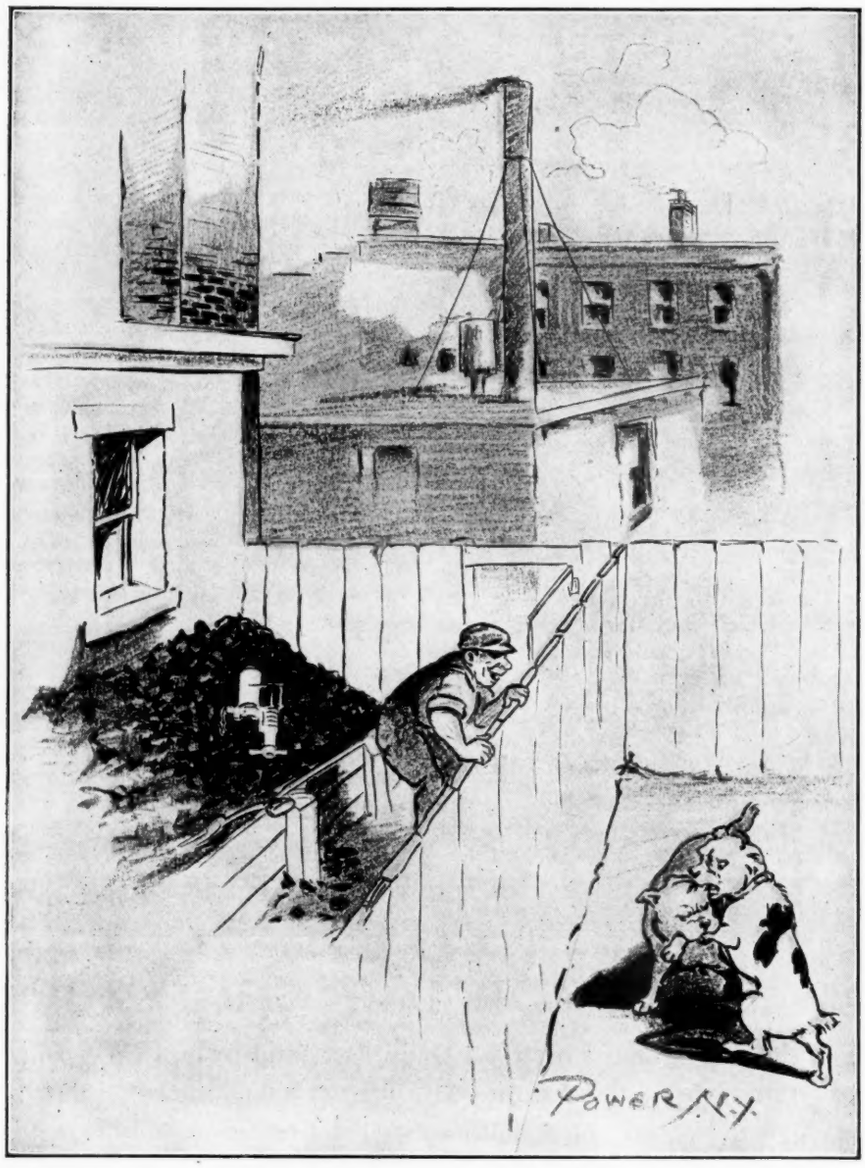
"That's just me," replied Schiester, "always lending something. One day I went over to see if he would let me have the use of his man to wheel in coal, as I didn't think it was the thing for any engineer to do. Of course I offered to come over and help him any time he got stuck.

"One day when I was over to his place to borrow some piston packing I saw his new indicator. He was as tickled as a boy over a new toy, and wasted a lot of my time telling me how it worked. Of course his idea was to try and lord it over me just because I didn't own one. I call that kind of doings pretty mean.

"The next day I made up my mind that my engine wasn't working right, and so I asked Redfield to let me take his indicator for a couple of days. He didn't seem at all neighborly, but after waiting awhile said I could take it, but to be careful of it. Just as if I didn't know how to take care of an old indicator."

I replied that it was one of Redfield's traits to take care of his tools and that he expected others to do the same when they borrowed them.

"Well, he acted mean enough about it.



PUT THE INDICATOR ON THE COAL PILE AND GOT UP ON THE FENCE TO WATCH THE DOG FIGHT

I had used it and was on my way to return it four or five days after I had borrowed it when, just as I was passing the coal pile, I heard a dog fight on the other side of the fence. Now you know no one ever passes a dog fight, do they? So I laid the indicator down, nice and easy, on the coal pile and got up on the fence to watch the scrap. When someone called me in the engine room later on, I forgot all about the indicator, until Redfield asked me a couple of days later, while I was over borrowing a water glass, if I was through with it.

"I told him I had forgotten it and left it on the coal pile, and that I couldn't be expected to remember everything; but he acted mean about it. I told him I would bring it over as soon as I got the new glass in place. You can see that I was willing to do the square thing by him. He wasn't satisfied with that, but started out without stopping to thank me for telling him where his indicator was. When he got back he spent about three hours oiling and cleaning the thing—a regular waste of time, I think. He was mighty frosty for a time, and I have never been able to find out what it was all about.

"It wasn't long after that that I went over just for a friendly visit to show I had no hard feeling and borrowed some good sheet packing. It was quite a while before I got some of my own of a cheaper grade. I don't believe in high-price stuff anyway. Well, he saw the difference at once, although I don't know how he did it, for all sheet packing looks alike to me, and he told me that he expected me to return the same quality of packing that I had borrowed.

"Packing is packing, ain't it? That is just what I told him. He said I should make up the extra cost of the packing, but I ain't that easy. I don't look it, do I? Then I told him that I would never borrow another thing from him again, and he said 'thank Heavens.' Don't you think him pretty close? The next time I started to go in his plant I found the gate locked. I don't call that neighboring, do you?"

I evaded a direct reply, but honest, I don't blame Redfield for locking the gate.

A Driving Fit for Bushings

*BY C. H. BIERBAUM**

It may be of interest to some readers to consider the fact that a bushing can be driven in too tight to give the best results. As long as the bushing has no occasion to heat up, it matters little how tight it has been driven into place; the instant, however, the bushing warms up, the fact that it has been driven in too tight is very liable to make itself known, especially if the clearance for the shaft or journal on the ouside of the bushing is very slight. In this case, if heating occurs, the bushing cannot expand outwardly and all the expansion must occur inwardly. Say that a bushing left 0.001 inch large on the outside, is driven into place and that heating occurs, the inward shrinkage of the bushing will then have to exceed the 0.001 inch, because the volume of metal represented by the thickness of the 0.001 inch on the outside of the bushing will be considerably greater than the amount represented by the same thickness on the inside of the bushing. In addition to this, the hub or housing into which the bushing is driven is strained or enlarged by the very process of driving and, upon heating, the hub will tend to resume its original dimension, causing an additional amount of compression of the bushing, all of which will have to be taken up by the clearance allowed for the shaft or journal in the bushing. Bushings should be driven in just firmly enough to prevent any looseness under service conditions, and any excess of forcing beyond this point is positively detrimental. The following rule for clearance has given very general satisfaction:

*Vice-president of Lumen Bearing Company, Buffalo, N. Y.

$$Db = 1.001\ Ds + 0.001,$$

where

Db = Internal diameter of bushing or bearing,

Ds = Diameter of shaft or journal.

Expressed in words, the clearance in a bearing should be 0.001 inch plus an additional thousandth for every inch of the diameter of the shaft.

It is desirable to have the bushing of uniform thickness throughout; that is, a circular section of uniform thickness. Bushings with ribs on the outside, designed to economize materially, are liable to have shrinkage strains in them, because when there is an unequal thickness of metal, the metal within the lighter sections cools first and the heavier parts afterward. After such castings are finished and driven into position, the first warming or heating of them tends to distort their inner or wearing surfaces, often giving rise to trouble and annoyance without any apparent reason.

For the same reason, that of economizing material, it is often found that the hub or housing is cut away so that only ribs are left to support the bushing. This, to some extent may be done; but, in many cases, it is carried far beyond a permissible limit and leaves an inadequate surface for the outside of the bushing and, on first heating, permanent distortion of the bushing occurs, due to the walls of the bushings sagging between supported points.

Lubrication and Lubricants*

Tests on Various Oils and on Graphite Mixed with Kerosene, Water, Fuel Oil, Cylinder Oil, And Spindle Oil to Determine Coefficients of Friction

BY C. F. MABERY†

Next to the conservation of the world's fuel supply there is probably nothing of greater importance to the manufacturing world than the control of waste power caused by imperfect lubrication and needless friction. The immense losses from this source are scarcely appreciated. It is safe to state that they amount in this country to anywhere from 10 to 50 per cent. of the power developed. The manufacturer often knows very little concerning the economic qualities of the lubricants he buys. In using them, too much is left to rule-of-thumb methods. Little knowledge is possessed of the actual conditions of friction, the action of metallic surfaces under the dynamic stress of the transference of power, or of such modified action as is produced by the intervention of a lubricating film. For example, the different effects on a journal produced by a soft and a hard bearing may be sufficient to cause a considerable loss of power if improperly selected, and yet escape attention. In the earlier days of machinery lubrication, before the introduction of petroleum products, the manufacturer had little concern about viscosity and other physical properties of lubricants, for, dealing with simple oils or greases of definite composition; he could be sure of obtaining what he desired within the capacity of the material at his disposal. Then in the days of higher prices of manufactured products and less severe competition, imperfect lubrication was of less consequence than it is now when every detail of cost and loss is receiving careful attention. The discovery that the heavy hydrocarbons in petroleum possessed the qualities requisite for lubrication, viz., viscosity, durability and stability under varying conditions of speed and load, was the beginning of a new era in lubrication. Crude oils of the Pennsylvania type containing a considerable portion of the hydrocarbons $C_n H_{2n+2}$ have always yielded excellent light spindle oil composed for the most part of the hydrocarbons $C_n H_{2n}$ and $C_n H_{2n-2}$. But as we now know this type of oil includes too small a proportion of the heavier hydrocarbon for the body necessary in lubricants subjected to the great stress of heavy loads and cylinder friction. The need of heavy lubricants led to the practice of compounding oils, or mixing with the petroleum products various proportions of the vegetable oils, such as castor or rape, and the various animal oils or greases. Manufacturers were often led to believe that no other product would serve equivalent purposes; even since the more recent introduction of heavier lubricants made from Texas and California petroleum, the belief still prevails that only compound oils can be relied upon for heavy work. But with care in distillation and treatment, it is certain that heavy lubricants well adapted for bearings and cylinders may be prepared from these crude oils and large quantities of such lubricants are now widely in use.

All experimenters with lubricating oils who have given thoughtful attention to the essential means of lubrication have been impressed by the superiority of an ideal solid lubricant, one that would combine an equivalent of the desirable qual-

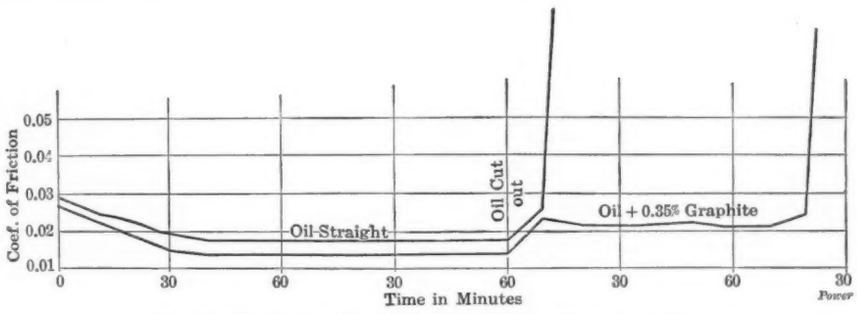


FIG. 1. FRICTION CURVE OF AMERICAN CYLINDER OIL

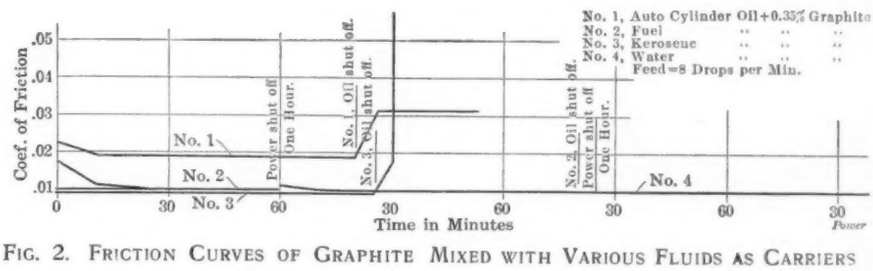


FIG. 2. FRICTION CURVES OF GRAPHITE MIXED WITH VARIOUS FLUIDS AS CARRIERS

ities of the liquid products with a greatly superior wearing quality and a low coefficient of friction and be readily convertible into a form that could conveniently be applied to various forms of journals and bearings. Greases com-

*Abstract from paper presented to the American Society of Mechanical Engineers, January 11, 1910.

†Professor of chemistry, Case School of Applied Science, Cleveland, O.

pounded with graphite are useful on low-speed bearings and under heavy work. Natural graphite serves to excellent purpose on cast-iron bearings, acting as a surface evener of the porous metal. On finer surfaces care is necessary to prevent it from collecting in such quantities as seriously to scratch or abrade the journal and bearing. Of all non-liquid materials available for lubrication, graphite possesses the desirable unctuous quality and great durability. For use in lubrication graphite must be in its purest condition and in a state of extreme subdivision. Such graphite is now produced by processes discovered, perfected and placed on a manufacturing basis by Dr. Edward G. Acheson, of Niagara Falls. He has succeeded in producing a graphite in a deflocculated condition which meets the requirements of an ideal solid lubricator. This deflocculated form greatly surpasses ordinary graphite in unctuous quality and its adaptability for long suspension in water and oils renders it especially applicable for lubricating purposes. Furthermore, the readiness with which it forms coherent films on journals, its great wearing qualities, and the ease with which it can be applied make it a lubricant of extremely high efficiency. Acheson graphite can be produced from any substance that contains carbon in a nonvolatile form. Under the extreme temperatures of the electric furnace all other elements are readily volatilized. As commercial products, two forms of graphite are produced, the unctuous and the deflocculated modifications. The first form accompanies the production of carborundum in furnaces charged with carbon and sand. The second is obtained from a charge of coal or coke alone. The first form is leafy in structure, coherent and extremely unctuous or greasy in its feel. It is segregated and not readily disintegrated. The second form is also unctuous to a high degree, but very pulverulent and capable of extreme subdivision. It is readily converted into a deflocculated condition and in this form in water comprises the commercial "Aquadag" or aqueous, Acheson deflocculated graphite. In combination with oils it is known as "Oildag."

Graphite in this deflocculated condition has peculiar properties. It remains suspended indefinitely in water but is quickly precipitated by impurities. On account of its extreme subdivision a very small amount suspended in water serves for efficient lubrication. From numerous and long continued trials it appears that 0.35 per cent. serves adequately, and that a larger proportion is superfluous.

Proper lubrication of bearing surfaces involves careful consideration of the material composing the journal and bearings, since the metal influences the effect of even the best lubricating films. The materials in common use include cast iron, steel and alloys of various compositions, included under the general terms bronze and babbitt. In high-speed work cast-iron bearings must be used with extreme care. Results obtained by the use of bronze have not been altogether satisfactory. Properly selected babbitt, however, seems to fulfil the desired conditions satisfactorily, and it possesses a wide range of applicability. Satisfactory lubrication is possible only when the journal and bearings are properly milled to true surfaces, kept smooth, and accidental scratches worked out and bare spots avoided. Successful lubrication demands constant skilled attention to the condition of the journal and bearings, and no factory supervision affords more desirable returns.

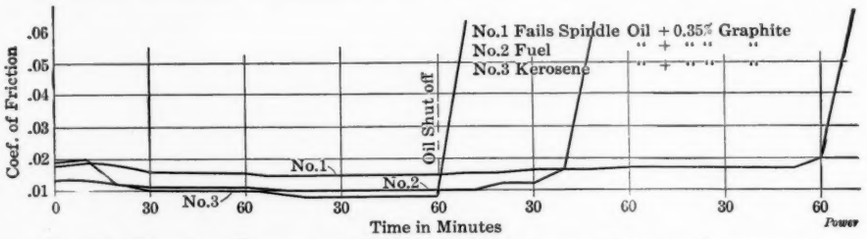


FIG. 3. FRICTION CURVES OF GRAPHITE MIXED WITH OILS OF DIFFERENT VISCOSITIES

We present herewith some results from an extensive series of tests on various kinds of oils, and water in combination with graphite. The tests for physical properties were conducted on an improved Carpenter testing machine, which possesses accurate adjustments for recording speed and friction loads. The capacity of the machine is 6000 pounds, total load. In projected area the bearing is approximately 8 square inches. The journal is about 3 inches in circumference and nearly one foot long in linear extension. The machine is so constructed that the journal is partially exposed, thus permitting the operator to observe the condition of the lubricating film. The results obtained with the use of water, kerosene and fuel oil as vehicles of graphite, present novel and interesting features. Under certain conditions as in steam cylinders, it is well known to engineers that water alone serves as a lubricating film, but since in journals it serves to no purpose whatever, the lubricating qualities of aqueous suspended graphite must be due wholly to the graphite. The same is true of kerosene which alone practically is devoid of lubricating quality, and likewise of fuel oil.

Fig. 1 shows the friction curve of tests of American cylinder oil with and without graphite. This is a straight hydrocarbon oil. A bronze bearing was used during the tests. The frictional pressure was 150 pounds per square inch; the speed, 245 revolutions per minute and the rate of feed, four drops a minute. The curve of the oil straight begins at a somewhat higher coefficient than is maintained after the first half hour when normal conditions are established, and it then proceeds in a straight line with no variation to the point where the feed is stopped; the endurance run of this oil is considerably shorter than it would have been had babbitt bearings been used; this was demonstrated in another test in which babbitt was used. With graphite the oil follows closely the direction of the other curve, but with a very considerable diminution in the coefficient of friction. In the endurance test the graphite carried the load with slightly increased

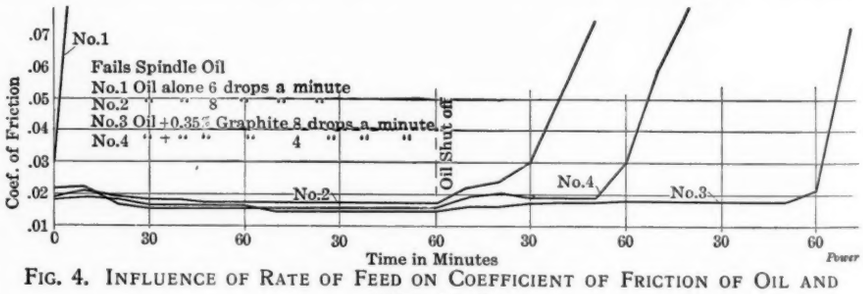


FIG. 4. INFLUENCE OF RATE OF FEED ON COEFFICIENT OF FRICTION OF OIL AND "OIL DAG"

In Fig. 2 the friction curves of graphite and four different carrying fluids of different viscosities are shown. The load was 70 pounds per square inch; the speed 446 revolutions per minute and the rate of feed, eight drops per minute. The curve for water and graphite is practically a straight line. The test was continued for fifteen hours with no variation in the results obtained. The power was shut off for an hour several times without producing any effect on the coefficient of friction. The coefficient of kerosene and graphite was found to be slightly lower than that of the water and graphite as is shown by curve No. 3. The auto-cylinder and fuel oils showed friction for a period of one hour and twenty minutes.

a high coefficient at the beginning of the tests. This is probably due to their greater viscosity. The auto-cylinder oil showed a much greater endurance than is shown by the curve.

In Fig. 3, curve No. 1 shows the coefficient of friction of Fails spindle oil and 0.35 per cent. graphite. No. 2 is the friction curve of fuel oil and graphite and No. 3 is the friction curve of kerosene and graphite. The speed at which the tests were made was 445 revolutions per minute, the rate of feed was eight drops a minute and the pressure 150 pounds per square inch. Kerosene shows a very slight irregularity in its coefficient, which differs only slightly from that in the preceding chart. Here again the greater internal viscosity of fuel oil is shown by the increased friction which appears in its curve. No doubt the fuel oil possesses the quality of oiliness in a very slight degree which enables it in the beginning of the test to take a lower coefficient than kerosene, which maintains for a few minutes a considerably higher coefficient until the continuous film of graphite has formed and reduced the coefficient to its normal condition. It is evident that the fuel oil also possesses a certain oiliness which enables it to begin the test with a coefficient that changes only slightly during the entire period, which includes also an endurance test extending through two hours before the oil breaks and with only a slightly increased coefficient of friction after the oil supply was shut off. A feature worthy of note is the comparative endurance of the three oils. While kerosene under a bearing load of 150 pounds per square inch maintains an extremely low coefficient, the fact that it breaks immediately when the oil supply is shut off indicates that it has not the power to form a coherent graphite film, which is possessed in a considerable degree by the fuel oil and to a marked degree by the spindle oil.

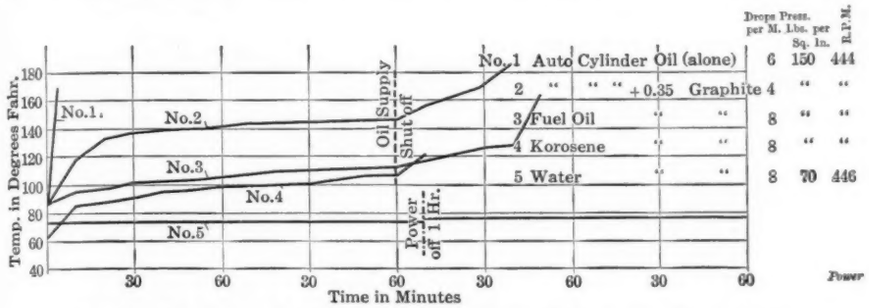


FIG. 5. TEMPERATURE CURVES OF GRAPHITE MIXED WITH DIFFERENT FLUIDS

The influence of graphite and the rate of feed on the coefficient of friction and the durability of Fails spindle oil is shown in Fig. 4. During these tests the speed was 445 revolutions per minute and the pressure 150 pounds per square inch. The feed for test No. 1 was six drops per minute, for Nos. 2 and 3 eight drops and for No. 4 four drops per minute. The diminished coefficient in curve No. 4, as compared with curve No. 2, represents the lubricating effect of graphite. Its influence on the durability is also illustrated by the longer endurance run of test No. 4 during which the rate of feed was only half of that in test No. 2.

The temperature curves of graphite in combination with various carrying fluids are given in Fig. 5. The temperature curve of the auto-cylinder oil rises rapidly from the start of the test and corresponds to the friction-coefficient curve for the same oil shown in Fig. 4. The high temperature maintained by the auto-cylinder oil containing 0.35 per cent. of graphite is due, no doubt, to the greater internal resistance it possesses. The curve for water and graphite shows a remarkably low temperature for the entire test which lasted 15 hours. The power was shut off several times but, as shown, the temperature at the start was the same as that at the time of interruption.

Fun with the Vacuum Bottle

In our November issue we printed an article from POWER AND THE ENGINEER, explaining the reason why the liquid in a vacuum bottle remains cold three times as long as it remains hot. The article has caused quite a little comment. A little consideration of the matter and the explanation given, would have shown its incorrectness. The explanation was evidently based on Newton's law of cooling, which is that "The quantity of heat lost or gained by a body in a second, is proportional to the difference between its temperature and that of the surrounding medium." The statement, "A difference of 180 degrees exerts three times the pressure or tendency to change that a difference of sixty degrees does," is entirely correct, but the conclusion, "the 180 degrees change will take place in one-third the time," is wrong.

The writer fell into the error of thinking that this relative rate of change held during the entire time the temperature was falling. This is not true. The rate of change in the temperature of the body originally at the higher temperature decreases as the temperature lowers, until from the original temperature of the second body it cools at exactly the same rate.

We wish now to offer another explanation.

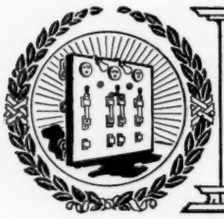
The vacuum bottle consists of a double-walled bottle with about ¼ inch space between the walls. The surfaces of this interior space are silvered so that the outside of the bottle and the inside of the bottle present a highly mirrored surface. This glass bottle is contained in a metal cylinder, also highly polished on the outside, so that the bottle, considered as a whole, shows two mirrors facing outward and one mirror facing toward the inside of the bottle. Any ray of heat passing from the outside into the bottle, is opposed by two highly reflecting surfaces. On the other hand, any ray of heat passing from the inside out, is opposed by only one highly reflecting surface. This in itself is sufficient to explain the difference in the rate of cooling, but there is still another reason.

When the bottle is at a temperature above the surrounding medium, rays of heat are radiated from it in every direction and from every point of its surface. On the other hand, when a bottle is at a lower temperature than the surrounding medium, the absorption of heat is hindered by the fact that most of the heat rays strike the bottle slantingly and are reflected at an angle.

The parallel to this condition exists in the manner in which the rays from the sun strike the earth at our latitude during the winter time, the great angularity of a ray with regard to the surface accounting for our lower winter temperature.

These two explanations, we think, cover the point in question.

In addition, we desire to add, that the existence of a vacuum between the walls of this bottle probably does not have much to do with its operation, as radiant heat passes through a vacuum as well as through air or gas, as evidenced by the passing of the sun's rays through the extremely rare atmosphere between the sun and the earth.—*Graphite.*



ELECTRICAL DEPARTMENT

Especially conducted to be of Interest and Service to men in charge of Electrical equipment.

Care of Air Blast Transformers

By Norman G. Mead.

In the operation of blowers for cooling air-blast transformers, considerable power may be saved by the proper adjustment of the dampers. The cross-sectional area of the air ducts in an air-blast transformer is considerably greater than the area required for the pressure and volume of air specified for cooling it, and the proper regulation of air is accomplished by adjusting the dampers.

In cases where the air chamber or duct is long and of small cross-section, the pressure under the nearest transformers will naturally be greater than the pressure under those more remote. If, therefore, the dampers on all the transformers were adjusted to the same degree of opening, the transformer nearest the blower would receive the greatest volume of air, and if the blowers were run at the speed necessary to furnish the most remote transformer with its proper supply of air, there would be considerable waste of energy in blowing more air through the near transformers than they required. The dampers of transformers located where the pressure is lowest should be opened wider than those where the pressure is highest, that is, the dampers should be adjusted so that the proper volume of air flows through each transformer.

Where the air supply is in excess of that required, and the pressure is approximately the same at every part of the chamber (but not less than specified), the hinge type of damper may be set 40 per cent. open and the slide-grate type wide open.

After adjusting the dampers, the transformers should be closely watched until they have reached the maximum opening temperature. If the transformers are operating beyond the safe temperature it can easily be detected by noting the temperature rise of the outlet air. This should not exceed 15 degrees Centigrade (12 degrees is a good value) when operating at full load, and when operating at 25 per cent. above full load the rise should not exceed 23 degrees Centigrade. A record of degree of opening should be kept so that it will be possible to detect at any time if the dampers have been tampered with.

Whenever a change has been made in the combination of operating transformers, it may be necessary to readjust the dampers in order to give all transformers the same air pressure.

To select the proper fuse for either the primary (high-tension) or the secondary (low-tension) leads, divide the rating of the transformer expressed in watts by the voltage of the circuit; the result is the current in amperes, for which the fuse is to be selected. In the case of a three-wire circuit, use the voltage between the outside wires.

If an air-blast transformer has been properly installed and operated for a short time successfully, it should continue to operate successfully for a number of years if the proper care is given it. The dampers should be examined each day, particularly in installations where others besides the regular attendants are allowed to enter the room. The temperature of the outlet air should be frequently noted, as its rise will indicate whether the transformers are receiving their proper supply of air. If the outlet air temperature at the normal load is more than 15 degrees Centrigrade higher than the inlet air, the cause should be ascertained and corrected immediately.

In operation, air-blast transformers collect dust and dirt in the air ducts and they should be cleaned at least once a month, and more frequently where it is required. There are plants where this type of transformer is cleaned every day, but these are located in a country where there is a great deal of wind and the soil is very sandy.

The openings between the coils should be cleaned as thoroughly as possible with a felt swab, and all outside parts should be brushed. In addition the air ducts should be cleaned out by means of compressed air, at about 20 pounds per square inch. When cleaning by air it is advisable that the dampers of all transformers (excepting the one being cleaned) be closed, and the air should be blown through the transformers from the bottom, blowing into the room.

Care should be taken, when removing parts such as the top dampers and top casting, not to drop screws and nuts into the coils, and in cleaning with a brush special care should be exercised to avoid injuring the insulation.

In case of a complete breakdown of a blower outfit a transformer may be operated at approximately one-half its normal load for periods not exceeding one hour. When operating without the air all panels in the housing and all dampers should be opened. The maximum temperature of the coils when operating in this manner should not be allowed to exceed 35 degrees Centigrade (95 degrees Fahrenheit).

Every large air-blast transformer installation should be provided with an air compressor capable of compressing the air to about 25 pounds per square inch for cleaning the air ducts of the transformer.

Overheating of an Exciter

Since writing my last letter on exciter troubles, published in the January 18 issue of Power, I have had an experience with a new 6-kilowatt exciter which may be interesting. It is a compound-wound 125-volt machine running at 1800 revolutions per minute. When delivering only 20 amperes, the commutator, brushes and bearing became very hot. The heat seemed to come from the commutator, and after a 12-hour run the commutator would be extremely hot, but not hot enough to sling the solder from the leads. The continual heating caused the commutator to become elliptical, however, and this of course made the trouble worse, and the resultant sparking was bad. Turning the commutator down did not relieve the heat. Every known condition that could cause the trouble was investigated, and it was made certain that the trouble was not an electrical one. The bearing on the commutator end was taken out; the bearings were of the oil-ring type, with composition sleeves. When the bearing was examined, it was found that instead of the oil grooves of one end extending to the ring slot, which was about ¼-inch from the end of the bearing, the grooves were left unfinished; that is, they lacked fully ⅜-inch of running into the ring slot. After cutting the grooves to the ring slot and assembling the machine, everything went as cool as it should. Some such trouble might have existed in the machine which Mr. Walker described in the November 2 issue.

L. Earle Brown.

Roundup, Mont.

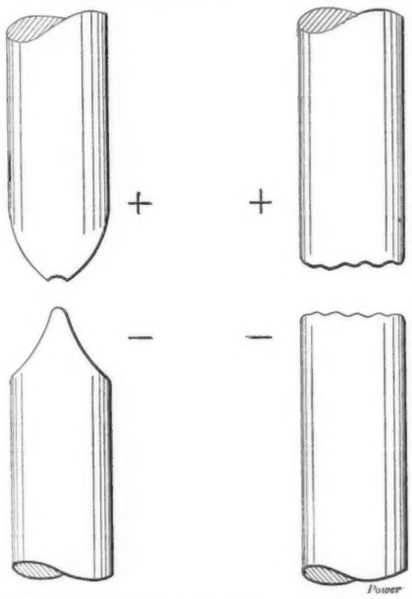
Arc Lamp Carbons

Replying to R. Manley Orr's article in the January 18 issue, I wish to say that Mr. Orr is probably using inclosed-arc lamps, which always burn their carbons off square as he shows, while Mr. Fenkhausen's sketch is correct for an open-arc lamp. Mr. Orr can tell when his lamp is burning right side up, without shutting off the lamp, by noticing the tinge of the globe. When the lamp is burning right the upper half of the globe will be of a bluish tint and the greater part of the light will be thrown down toward the floor; this is due to the reflection of the crater in the upper carbon.

W. T. MEINZER.

Brooklyn, N. Y.

Reading R. Manley Orr's letter on arc-lamp carbons in the issue of January 18, it occurred to me that the lamps that he dealt with were inclosed-arc lamps, the carbons of which as a general rule take on the appearance shown at the right,



CARBONS FROM DIRECT-CURRENT ARC LAMPS

while the kind that Mr. Fenkhausen had were of the open-arc type, where considerable oxygen surrounds the arc and causes the wasting away around the edges.

CHARLES B. POOL.

Deerfield, Mich.

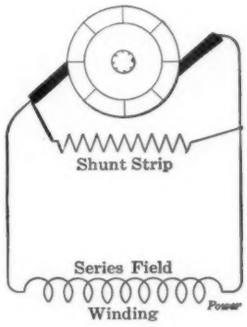
Referring to my letter in the January 18 number I wish to say that since then I have gone to a little trouble to solve my own problem. I find that both the carbons in an inclosed direct-current arc lamp will burn almost perfectly flat on the ends. What Mr. Fenkhausen says in his article is only true of the direct-current carbons when burning in the open. The arc when inclosed will travel in a circle round and round the carbon ends and thus it is that they burn evenly and flat.

R. MANLEY ORR.

Brantford, Ont.

Trouble with the Shunt Strip of an Alternator

I have been having trouble with the shunt strip of a compound-wound alternator which was originally a 2200-volt machine but has been changed to 1100 volts by "doubling up" the armature winding. The shunt strip is a short one connected across the brushes of the rectifying commutator from which the



current for the series field winding is taken. The brushes spark badly and the shunt strip gets hot as the load gets up toward the full-load point. The full-load current is 52 amperes but it goes to 60 for about two hours. The machine tests clear of grounds with a magneto, but when the switchboard ground detector is connected to it, a string of sparks runs from the commutator to the shaft, especially if the opening happens to be a little dirty.

Will some other reader suggest what the cause of the trouble is and how to correct it?

JOHN BERKLEY.

Homer, Ill.

[Part of your trouble may be that the shunt strip was not changed to correspond to the doubled load current when the armature winding was changed from 2200 to 1100 volts. This change increased the full-load current from 26 amperes to 52 amperes, and if the shunt was not doubled in cross-section it is too small to stand the 100 per cent. increase in current. The overload of eight amperes also has an unfavorable effect on the shunt. Of course, the whole armature current does not pass through the shunt, but the current that does pass through it is exactly proportional to the armature current. Furthermore, if the shunt was not changed, its resistance is too high to take the discharge of the series field winding properly at the moment of short-circuit, and this would produce excessive sparking at the brushes.—EDITOR.]

Reversing a Shunt-wound Motor

There was a motor in the boiler room used to operate an elevator for removing the ashes. The belt from the motor to the pulley on the shaft of the elevator machine was crossed in order to run the machine in the correct direction. The chief engineer asked if I could reverse the motor, and thereby work with a straight belt instead of a crossed belt, and added that the motor seemed to be "hoodooed" as none of the men about the plant had succeeded in getting it to operate satisfactorily in the reverse direction. I told him I thought I could do it, and got busy.

The motor was an old shunt-wound machine of the bipolar type and fitted with carbon brushes set tangent to the commutator, as indicated in Fig. 1, instead of being set radially, as in Fig. 2, which is the case in most modern motors. I first reversed the brush holders to give the brushes the correct angle the other way, fitted the faces to get good contact, and then changed the field

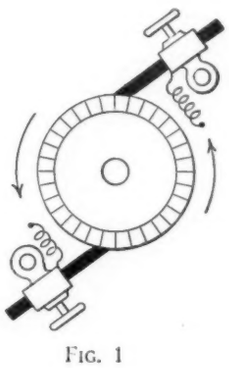


FIG. 1

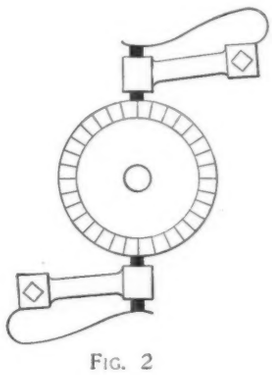


FIG. 2

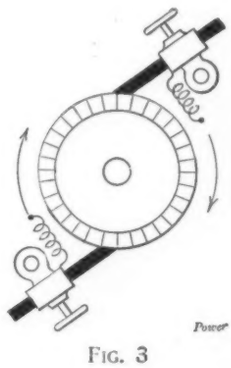


FIG. 3

connections. It ran in the reverse direction, but you ought to have seen the fireworks. I shifted the brushes backward as far as they would go and succeeded in cutting down the sparking, but it was still too much to consider operating the motor in such a condition, so I reversed the brush holders and field connections back to their original condition and let the crossed belt stay for the time being.

A few days later I got a hurry-up notice that the belt had broken and one end had fallen into a gear and was so badly chewed up that after it was trimmed there was not enough to run crossed, so they were putting it on straight and wanted the motor reversed "right away quick—let her spark."

I did not stop to reverse the brush holders, but just changed the field connections and started the motor; it ran with less sparking than before, and with a little shifting of the brushes it ran perfectly, without a spark.

The chief came up to see how it was acting and was agreeably surprised to see it running without the usual sparking, but asked why I had not reversed the brushes; the commutator was running against them, as shown in Fig. 3. Then he "tumbled." The construction of the brush holders and yoke was such that with the brushes reversed it was not possible to shift them far enough to find the neutral point. The motor ran in that way for about a year, when it was removed to be used for other work, and at no time did we have any trouble with it.

G. S. SPRAGUE.

Geneva, Neb.

A Storage Battery Trouble

In my care there are 50 small storage-battery cells with a capacity of five ampere hours each, which are used about once a month, and in order to keep the cells in operative condition it is necessary to charge and discharge them at short intervals. The charge and discharge should be carried on as economically as possible.

When discharging, the battery is used to run a one-eighth-horsepower exhaust fan, and when the battery is charging, the fan is operated from the 100-volt busbars. The only style of switches to be used is the knife-blade type.

The accompanying diagram shows the arrangement I have used. Can any other readers devise a scheme to cut down the number of switches used or reduce the amount of wiring?

MALCOLM C. SAEGER.

New York.

Stray Electricity

The experience cited in the December 21 issue by Weldy S. Yeager seems a bit out of the ordinary. The trouble with the telephone line can probably be accounted for, especially when the telephone lines are on the power-line poles or nearby. I have known telephones to give very severe shocks upon taking down the receiver, when the telephone lines were on the same poles with high-potential long-distance transmission lines. Under such conditions each telephone should have a few short spark gaps to ground.

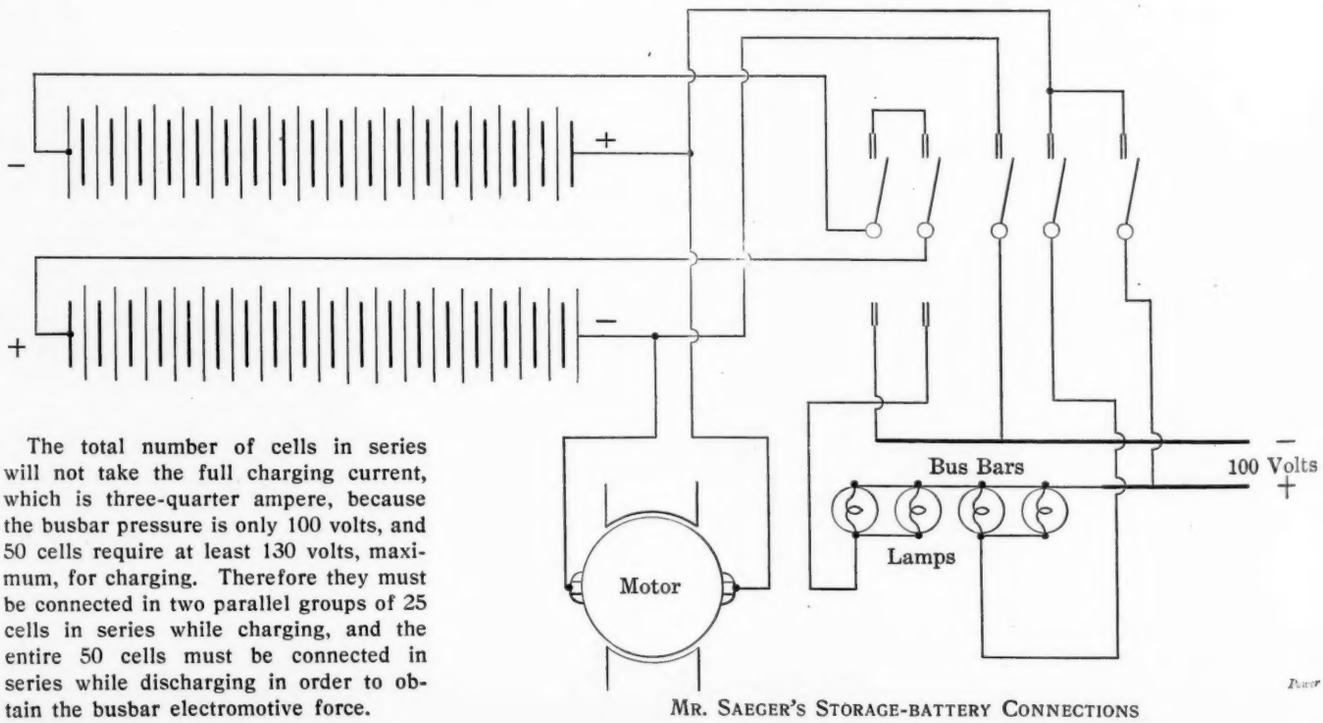
The cases of the ladies and the boy present something not so easily accounted for. If the earth around the pipe line was very dry and the telephone line should become highly electrified, it might electrify the water piping, as it is grounded to it. I think if Mr. Yeager will take a voltmeter and test from the faucets to a good ground, he will find no difference of potential, the charge or shock that was received being only a static one. I think it will be found upon the same principle that one can receive a shock or note a perceptible spark from a long header or steam line when there is steam escaping from a valve or joint, causing the pipe to become electrified statically.

Securing a copper wire to the faucets and fastening it to a pipe or rod driven into wet earth might relieve the trouble.

L. EARLE BROWN.

Roundup, Mont.

The British Board of Trade report No. 1872 deals with a case of scalding which occurred on board the steam trawler "Hunter" on July 30 last, and illustrates the danger of stopping defective smoke tubes in high-pressure multitubular boilers by means of simple plugs. It appears that in the case in question one of the smoke tubes of the boiler, which was of the ordinary single-ended marine type, and worked at a pressure of 160 pounds on the inch, had become defective, and to stop the leakage which ensued soft wood plugs were driven into each end. These were, of course, simply held in place by the friction between them and the tube, and were unable to resist the pressure of 160 pounds to the inch, which gradually accumulated in the interior of the tube, and formed a total load of over half a ton. Warning of the unsatisfactory character of the repair was afforded by the blowing out of one of the plugs when the steam pressure was only at 90 pounds, but the attendants neglected it, and simply drove the plug in again. Soon afterward it was observed that the plug in the smoke box was leaking, and the attendant then attempted to drive it up with a coal hammer, but at the first blow it was shot out, and the two men looking after the boiler were badly scalded.



MR. SAEGER'S STORAGE-BATTERY CONNECTIONS

The total number of cells in series will not take the full charging current, which is three-quarter ampere, because the busbar pressure is only 100 volts, and 50 cells require at least 130 volts, maximum, for charging. Therefore they must be connected in two parallel groups of 25 cells in series while charging, and the entire 50 cells must be connected in series while discharging in order to obtain the busbar electromotive force.

GAS·POWER·DEPARTMENT

Everything worth while in the Gas Engine and Producer Industry will be treated here for the use of practical men

A Progressive Central Station in a Small Town

By L. A. Smelzer

The accompanying pictures show the equipment of a very satisfactory little gas-power central station in New Windsor, Md. The plant was installed about four months ago, and consists of a Smith anthracite producer, a 50-horsepower Bruce-Macbeth two-cylinder engine and a Bullock direct-current dynamo. It has been in regular operation ever since it was first started up and has shown no signs of giving trouble. The engine has never failed to start promptly and has never stopped except when shut down at the end of each nightly run. At starting time, it takes the engineer just 15 minutes to poke the producer down and blow up the fire; then he is ready to start the engine.

The engineer's records show that the consumption of anthracite pea coal runs from 120 to 260 pounds daily; the average is 200 pounds in twenty-four hours, including stand-by loss. The load at the switchboard averages 18.4 kilowatts for six hours, or 11 kilowatt-hours, daily, and the cost of fuel is 40 cents per day. The engine consumes about one quart of good oil in the six hours' run. We have tested it running at one-third load for several hours and then put on full load; there was no excessive change in speed, the engine and producer taking care of the load change perfectly. This we believe to be due to the deep fuel bed we carry, together with the quick-acting steam regulator and the low rating of the producer. At the time of accepting the plant we tested it to 56 electrical horsepower at the switchboard for four hours, and the engine and producer showed no signs of overload; this load was carried on less than three-quarters of a pound of coal per brake horsepower-hour.

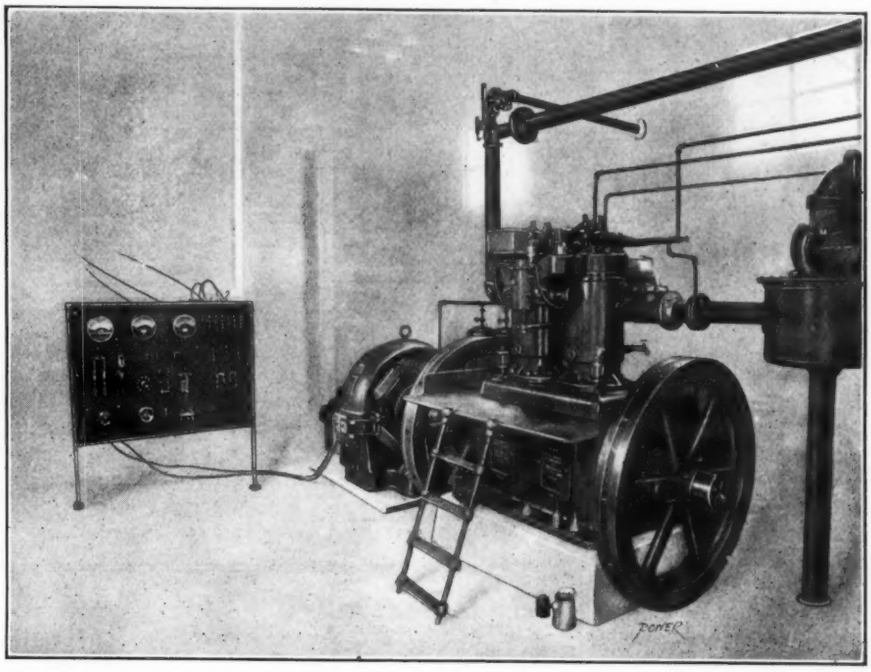


Fig. 2. Generating Unit and Switchboard

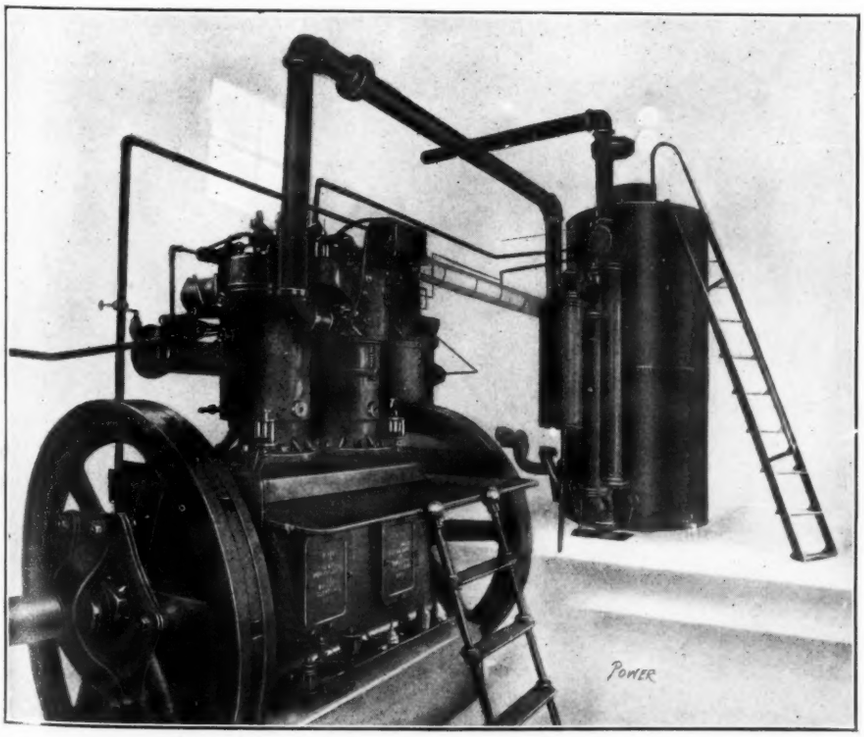


Fig. 1. Producer-gas Plant at New Windsor, Md.

Gas Engine Cylinder Lubrication

By Frank E. Booth

I have noticed, from time to time, that the majority of small gas engines of the trunk-piston construction have the cylinder lubricator placed as shown in Fig. 1. This location of the lubricator seems to do the work and yet it naturally occurs to the onlooker that better results might be obtained by dropping the oil into the cylinder at a point nearer to the breech end. If the oil went into the cylinder somewhere near the center, say at *A*, Fig. 1, it might get a more uniform distribution along the cylinder wall with less drip into the base at the crank end,

and make possible a saving in oil consumption.

A concern with which I was once connected redesigned a 15-horsepower engine having a piston with four rings, in which they placed the lubricating-oil hole for the cylinder so that the oil would drop on the second ring of the piston from the crank end when the piston was at the end of the outward stroke. The intention was to use the ordinary gas-engine lubricator with the ball-check valve below the sight-feed glass. The trouble with this arrangement was that the sight-feed glass would become so dirty that the operator could not tell how it was working; besides that it did not give good results on account of the pressure from the explosion playing into the lubricator to a certain extent. This may be one reason why the usual practice is to place the lubricator at the crank end of the cylinder. After trying various kinds of check valves between the cylinder and the lubricator without good results, it was decided to put a small air chamber between the lubricator and the cylinder. The air chamber as first tried was made from a piece of ½-inch pipe about 3½ inches long, both ends of which were plugged with a piece of cold-rolled steel which was cut off flush with the ends; some half dozen very small holes were drilled through the plugs. This construction gave indifferent results which led to the placing of but one small hole 3/32 inch in diameter in each end of the air chamber, as shown in Fig. 2, which worked without any trouble. The air chamber was screwed into the cylinder with a coupling on one end to take the lubricator. This apparatus keeps oil from blowing back from the cylinder to the lubricator, the action of the air chamber being to oppose the effect of any small pressure leak between the piston rings and the cylinder wall; and to give the check valve time to work.

The subject of cylinder lubrication brings to mind the fact that many people whom the expert on small gas engines runs up against do not always appreciate the necessity of keeping parts properly lubricated. One of the men was sent out of town, about 50 miles, to an engine which refused to run at all. All he did was to squirt a few drops of oil on the stem of the make-and-break igniter and the trouble disappeared. Another engine, one the writer went to see, persisted in running hot; a little extra oil on the piston was the remedy.

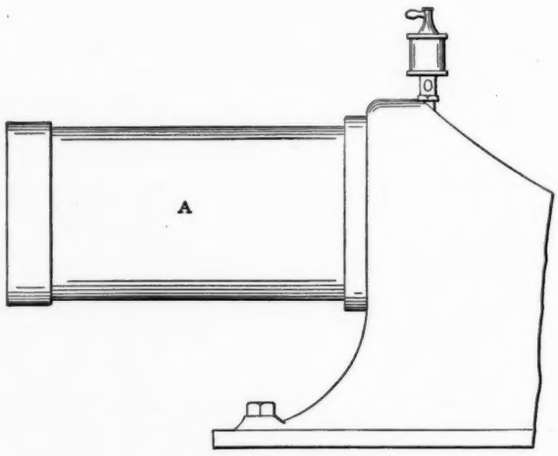


FIG. 1

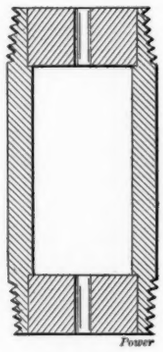


FIG. 2

A Reversing Crude-Oil Engine

The peculiar applicability of the two-stroke-cycle engine to marine service, by virtue of the facility with which it can be made to run in either direction, is illustrated by a little oil engine built in England and described in a recent issue of *The Engineer,* from which we reproduce the accompanying engravings. The engine is of the familiar type in which the air for combustion is drawn into the crank case by the upward motion of the piston, slightly compressed by the downward stroke, and admitted to the cylinder at the end of that stroke. The fuel, however, is not drawn in and compressed with the air, but is injected, at the end of the compression stroke, into a vaporizer or combustion chamber, as in the case of the well known Hornsby-Akroyd kerosene engine, and fired by the heat of that chamber, plus the heat of compression in the air.

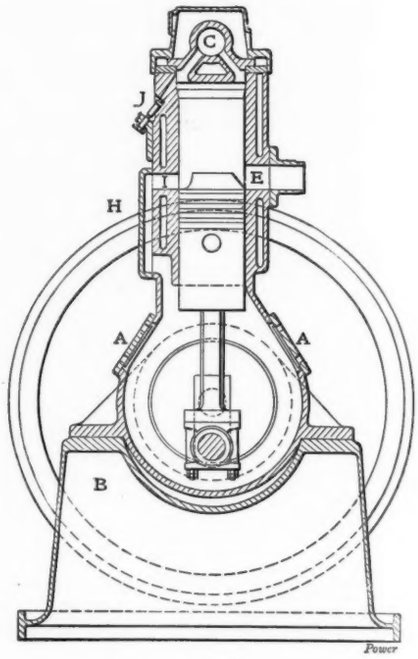


FIG. 2

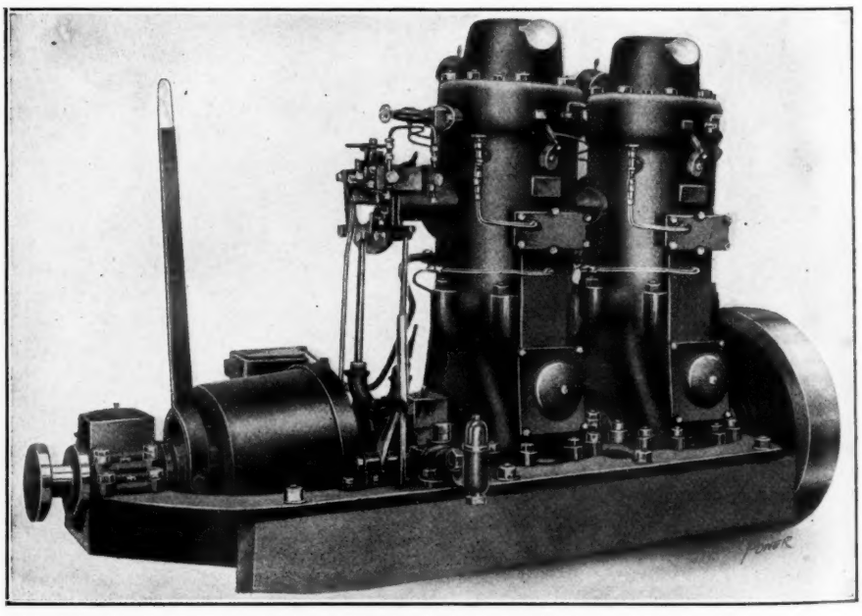


FIG. 1

Fig. 1 is a view of the complete engine with its auxiliaries, ready to couple up to the propeller shaft. Fig. 2 is a vertical section of one cylinder, where *A, A* indicate the automatic inlet valves of the crank case, *B* the subbase, *C* the vaporizing and combustion chamber, *E* the exhaust port, *H* the transfer passage, *I* the inlet port and *J* the oil nozzle.

The feature of the engine is the simple mechanism for operating it in either direction. This is shown in Fig. 3. The oil-pump chamber *O* is provided with two pump cylinders and pistons, the one, *C*, being for continuous operation in either direction and the other, *X*, coming into play momentarily for reversing the engine. Normally, the gear is in the position shown in the engraving. The shaft *S* is supposed to revolve clockwise, and the eccentric *E* oscillates the bell crank *B* in the proper relation to the piston travel to cause the pick-blade *T* on the plug *F* to operate the plunger of the pump *C* at the right moment in each cycle. The head of the plug *F* slides back and forth on the edge of a dog *I*, which is held against the stop *U* by the helical spring shown. A similar dog *J*, on the other arm of the bell crank *Q*, holds the plug *G* out of line with the end of the

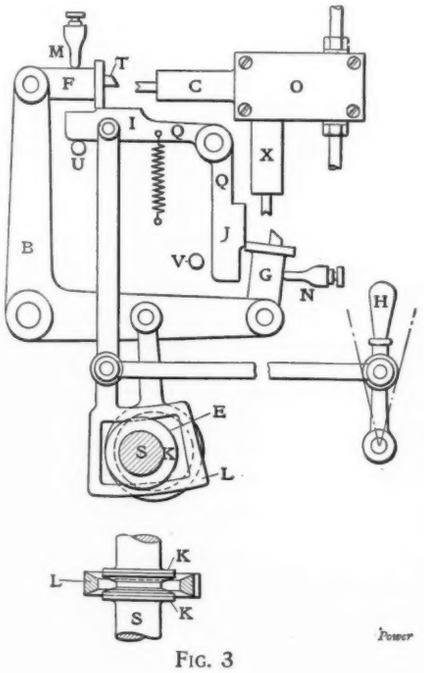


FIG. 3

plunger of the pump *X*, and the latter is idle under the conditions indicated. The plugs *F* and *G* are held against the dogs *I* and *J* by spring-backed noses *M* and *N*.

In order to reverse the engine, it is slowed down and the handle *H* is thrown to the right, which pulls the left-hand edge of the link *L* into engagement with the beveled friction disks *K, K*. The disks lift the link *L*, thereby raising the dog *I* and pulling the dog *J* against its stop *V*; this throws the pick-blade *T* out of alinement with the plunger of the regular oil pump *C* and puts the pump *X* into action. The timing is such that the pump *X* delivers a jet of oil to the combustion chamber far enough ahead in the compression stroke to force the piston backward and reverse the engine. As soon as the shaft *S* starts in the reverse direction, the friction disks *K* pull the link *L* down again to the normal operating position shown, and the regular pump *C* takes up its work again. When running backward, in order to reverse and "go ahead," the engine is slowed down and the handle *H* thrown to the *left*. As the shaft is turning oppositely to the arrow, this lifts the link, as in the other case, cutting out the pump *C* and cutting in the pump *X*, as before, just long enough to start the engine in the other direction.

Except when the direction of rotation is to be reversed, the handle *H* remains in the central position, holding the link out of contact with the friction disks.

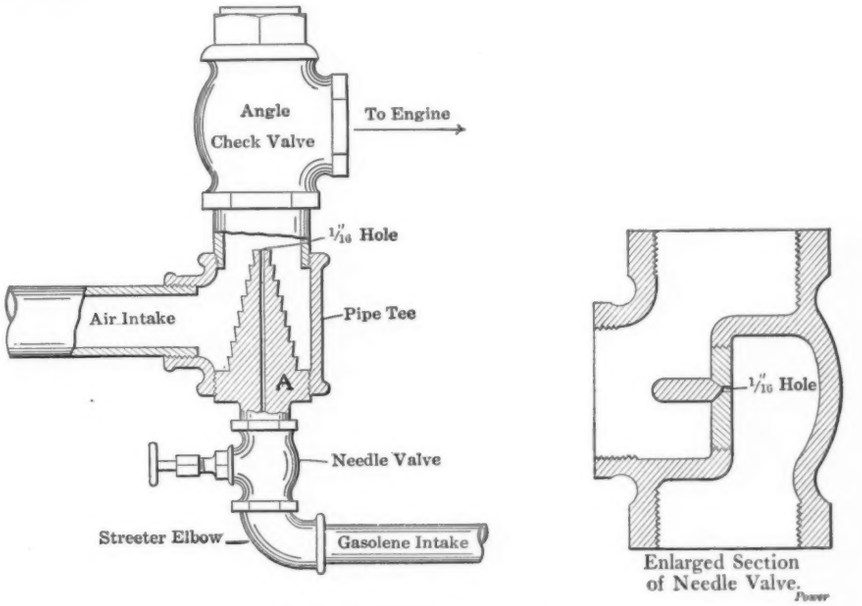
An 80-horsepower crude-oil engine of this type, built by the J. & G. Bolinders Company, Ltd., of Stockholm, and installed in a 60-foot fishing boat, was recently used to demonstrate the working of the gear for the benefit of the English technical journals. The engine had cylinders of 13 inches bore and 13.4 inches stroke, and it drove the boat from Hamburg to the Humber (about 350 miles) in 44 hours. The fuel consumption was not stated, but as the compression pressure is 150 pounds, the engine should show satisfactory fuel economy.

The South is now mining over 90,000,000 tons of bituminous coal a year, as compared with 42,000,000 tons, the entire bituminous-coal output of the United States in 1880.

CORRESPONDENCE

A Homemade Carbureter

The accompanying sketch shows a gasolene-engine carbureter of what is commonly known as the "generator" type, which works very successfully on the engine for which it was made, and probably will for any other such engine.



A HOMEMADE CARBURETER

The sketch is practically self-explanatory; the only part that may need a little description is the brass fitting *A*, which is the main feature of the vaporizer. It is made from a piece of round brass rod of the maximum diameter required, which is turned in a lathe to the shape here shown. A 1/16-inch hole is drilled through the center and the largest diameter near the bottom is threaded to fit the tee; the extreme lower end is turned down to a boss and threaded to fit the valve.

The gasolene supply is regulated by the needle valve; the gasolene comes up through the 1/16-inch hole, flows over to the first "terrace," and trickles thence down to the lower ridges, where it is readily picked up by the air drawn in by the engine suction.

V. T. KROPIDLOWSKI.

Winona, Minn.

What is declared to be the largest and most expensive leather belt ever made for driving purposes has been recently shipped from New York. The belt is 240 feet long, 6 feet wide, three-ply thick, and was constructed at a cost of $6000. To make the belt the hides of 540 steers were required.

From READERS *with* SOMETHING *to* SAY

Practical information from men on the job~A letter good enough to print is good enough to pay for.

Those Boiler Inspection Rules for Alberta

Our attention as a board of inspectors has been directed to an editorial in a recent issue of *Power House*, purporting to be a résumé of the conference recently held at Regina, Sask., Canada, for the purpose of considering the advisability of formulating uniform boiler rules for the Dominion. This conference was originally arranged by the steam-boiler inspectors of the two provinces of Saskatchewan and Alberta with a view to considering and recommending to the two governments the adoption of boiler rules which, by reason of their uniformity and thoroughness, would effectually and efficiently deal with the question of boiler construction and inspection in the two provinces, and to a greater extent than heretofore safeguard life and property where steam users are concerned.

Alberta, it should be mentioned, had already successfully adopted a set of rules to which all boilers entering the province must comply, and although the system had been but a short time in operation, it had been universally accepted as a progressive and much-needed measure by seller and purchaser alike, with the exception of one or two belligerent manufacturers who were loth to leave the path of antiquated, unsafe and unreliable designs, and who were apparently unwilling to pay a competent draftsman an adequate salary to steer them from the depths of their commercial shortsightedness.

Other provinces in the Dominion heard of this conference, and displayed a commendable interest in the matter. The Manufacturers' Association also scented it from afar, and as a result of voluminous correspondence between the officials of the various governments throughout the country, an inter-provincial conference was finally arranged to be held at Regina in December last.

Now, what we object to in the abovementioned editorial is the statement that the rules adopted by this conference were those presented by J. W. Harkom, representing the Canadian Manufacturers' Association. As a matter of fact Mr. Harkom did submit a set of something which he called "Steam Boiler Regulations," compiled from the rules of Saskatchewan, Alberta and British Columbia, with some ideas of his own, resulting in a pot pourri the adoption of which would have made the conference the laughing stock of the steam-boiler world. Mr. Harkom has, by the editorial in question, been given credit to which he is manifestly not entitled and which belongs to others, particularly to H. N. Blackburn, Wh. Sc., Sask., who pointed out many of the inconsistencies of Mr. Harkom's production.

JOS. BUXTON,
DAVID FRASER,
F. W. HOBSON,
NAT MARSHALL,

Board of Inspectors for the Province of Alberta.

Edmonton, Alberta, Canada.

Balanced Draft and Steam Jets

When a steam jet is used to produce a balanced draft, the dampers should be regulated so that when a handkerchief is suspended in the open furnace door it will be motionless. The steam jet should be regulated to suit the work done by the boiler. With the proper air pressure in the ashpit and the damper regulated so that the gases do not escape into the boiler room, the furnace will be filled with a bluish flame which comes from the burning hydrocarbon. If the dampers are opened wide it will be seen that the hydrocarbons are drawn from the furnace before they have time to ignite.

If the hydrocarbons are not burned as fast as they are distilled off, there is a serious loss of heat. It is important that no more air be allowed to enter the furnace than is necessary for complete combustion. If more air is admitted, it will escape up the chimney at a temperature of from 400 to 500 degrees Fahrenheit. On account of this extra quantity of air being admitted to the furnace, a large amount of heat is wasted and the temperature of the furnace is lowered. Water takes up heat much faster at high temperatures than at low temperatures. A good steam jet is one having a pipe 10 or 12 inches in diameter extending from the rear wall of boiler setting through the bridgewall into the ashpit and using a single jet of steam ⅛ to 3/16 inch in diameter. The steam will tend to prevent clinkers in the fire box. The jet should be connected to a damper regulator, the dampers being worked by hand.

HERBERT B. BRAND.

Brooklyn, N. Y.

How Can This Heater Be Cleaned?

In one of our plants we have a closed heater of about 300 horsepower that has become stopped up with scale.

It is constructed of inverted U-shaped brass tubes, and I have not been able to remove the scale from the bent part, as some of the tubes are bent to a radius of 2½ inches.

I have tried sulphuric acid, also soda ash, and succeeded in getting an opening through, but they soon filled up again when put in service. I kept the acid hot when using it, also boiled the soda ash in the tubes when trying it.

We have a water-treating plant, which accounts for the scale forming so rapidly.

I am going to put in an open heater and use the old heater at another plant where the water is not treated.

How can I clean the tubes so that the heater will be as good as new?

I would like to hear from anyone who has an idea, or has had experience.

W. F. SHUTT.

Darwin, Tex.

On Being Paid for Knowing Instead of for Doing

Soon after taking charge of a certain lighting plant it became apparent to the new manager that a change was needed in the force at the power house. It had been reported that the chief engineer had remarked that he "was paid for what he knew instead of what he did." From the appearances of things there was great need of doing as well as knowing.

As the new manager's acquaintance with the chief had been short, he had no idea how far the chief could be trusted with a notice that another man would be put in his place; so although he greatly regretted the necessity of his action he felt that the interests of the plant demanded it and one morning he handed the chief his check and told him that his services were no longer desired.

The plant was run by three shifts: the chief came on at eight in the morning and worked till six in the evening; the next man came on at six and worked till ten, having put in six hours at other work during the day, and the night man came on at ten and worked till relieved by the chief at eight in the morning. Each man did his own firing.

The equipment of the plant consisted

of one 250-kilowatt three-phase machine direct connected to a Corliss engine and a 90-kilowatt single-phase machine belted to a high-speed engine. There were three boilers. One was quite good though badly covered with scale. The other two had nearly outlived their usefulness and were scaled worse than the other.

The same day that the chief was let go the man on the four-hour shift was likewise disposed of. The man who had run on the night shift had held the job for quite a long time and had given entire satisfaction so the manager decided to try him in the chief's place. Two new men were secured.

After making the changes the manager started to see that some things were done. The heater received attention first. In this heater, which was of the open type, the cold water ran over a series of cast-iron pans in contact with the exhaust steam. The water ran over the outer edge of the first pan, falling into the second, which was in the shape of a ring. It ran out of the second over the inside of the ring into another small pan and so on over a series of about ten pans. When the manager had this heater opened the series of pans was found to be covered with a solid mass of scale so that the water had to run down the outside of the mass as best it could. The inside of the heater was coated with scale 2 and 3 inches thick. It was a long and hard job cutting the scale out so that the pans could be removed and cleaned.

After the heater had been cleaned other things about the plant were found that showed evidences of the same kind of knowing and doing. Various valves were found that were cut and leaking badly. The high-speed engine had been running much too warm at both bearings and an investigation revealed the fact that it had been allowed to get hot enough some time to let the babbit run and fill all the oil grooves. New oil grooves made a different running engine of it altogether. A drain pipe from the Corliss engine was found to be carrying two or three quarts of good oil to the sewer each day. By putting an oil trap on this pipe this oil was easily saved.

Other cases of neglect might be cited, but from the above the general condition of the plant can easily be imagined, and enough has been said to show that when an engineer begins to think he is being paid for what he knows instead of what he does his days of usefulness are about over. It takes but a slight change, however, to make that engineer's idea worth every engineer's careful thought. If he had said that he "was paid for what he knew as well as what he did," and had acted accordingly, he would have been a valuable man.

E. G. MILLER.

Denver, Colo.

What Caused Poor Diagrams?

Would like to get the opinions of POWER readers on the diagrams shown herewith. They were taken from a 17 and 34 by 42-inch Nordberg, tandem-compound

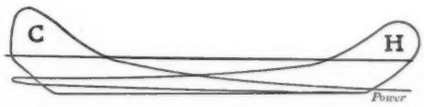


DIAGRAM FROM LOW-PRESSURE CYLINDER

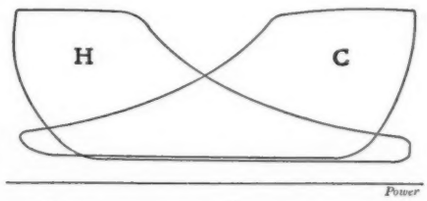


DIAGRAM FROM HIGH-PRESSURE CYLINDER

blowing engine running at 80 revolutions per minute. The engine had been shut down for some months and started up again without any change in valve setting. Before the engine was shut down it gave some very satisfactory cards. From all outward appearances the engine was working well when these cards were taken, the valve action being apparently as usual with the exception of the short duration of steam admission on the low-pressure cylinder. The indicator piping was not obstructed in any way, as might be imagined.

C. C. HOOPER.

Mapimi, Dgo., Mexico.

Locating the Pump Trouble

We recently installed a compound, duplex, feed pump the size of which was 12 and 20 by 10 by 18 inches. After packing it all around and tightening up a few nuts, which by the way, all builders leave loose, we turned the steam on and the pump started. It ran all that day and night. We shut it down the next day to give it a rest, so to speak. The day following, the new pump would not start. Of course it must be the governor that was stuck, we thought. We looked at it. But the governor was all right, so it must be that the throttle was off the stem. This was not it, however. The valve gear was of the outside type, and a very careful examination failed to show anything wrong. Next in order was to loosen up the glands on the plungers, these being of the outside-packed type; but this produced no result in the starting line. Next, we took off a few of the valve caps on each side of the water end, thinking that perhaps some of the discharge valves were stuck, but they all were O. K. We next took off each high-pressure cylinder head to see if we had a bad piston but did not find any. Then the low-pressure heads came off but they, too, were all right.

After each job we would try to start up; this kept the pump very warm so there was no danger of our fingers freezing.

We took off the steam-chest covers to see if the valves needed setting; they did not. Next for our attention was a speed-limit device. We took the valve of it out and found that it was all right.

Finally, after we did not have anything more to do to the pump and our supply of language was quite exhausted, I began to use my head a little. We had about 160 pounds steam pressure available at the pump and the water pressure was 230 pounds. Now the high-pressure cylinder area was 113.1 square inches; this times 160 equals 18,096 pounds pushing one way. The area of the water plunger equals 78.54 square inches; this times 230 equals 18,064 pounds pushing the other way. With the friction of the packing added to the latter figure, the pump had a perfect right to lie down.

We dropped the pressure to 200 pounds and the pump started off all right; after the low-pressure end began to get steam it was easy to raise the pressure again. Moral, put a bypass on all compound pumps.

EDWARD H. LANE.

Kansas City, Mo.

Uniform Size for Catalogs

The advertising pages of any good technical paper are an education in themselves, and the reader who lays aside his paper after looking over only the reading matter loses half of its value. And even superior to the advertising matter are the catalogs describing in greater detail the subjects advertised and which in most cases will be sent free to anyone interested enough to write for them. Very few engineers seem to realize the immense amount of information that may be gotten from trade catalogs or the value of keeping files of uptodate catalogs of firms dealing in apparatus in which they are interested. The progress of scientific advancement is so rapid in these days that a book is hardly more than printed before it is out of date. If we would keep up with the times we must supplement our books with catalogs.

Probably one of the main reasons why more engineers do not keep files of catalogs is that a great deal of inconvenience is occasioned in consequence of the many different sizes and kinds of catalogs issued. Some are large and heavy, some very small, and some so flexible that they will not stand on edge, so that the filing of a number of catalogs becomes an annoying matter. Many catalogs are, therefore, relegated to the waste basket, or hard to find even when

stored away for future reference. It seems to me that there is room for lots of improvement on the part of the manufacturers and that it would be well if they could agree on a uniform size and shape or devise some means by which at least a greater degree of uniformity could be established.

W. L. DURAND.

Washington, D. C.

Taking Care of Oil

One of the annoying incidents which the engineer runs up against in the winter months is trying to draw oil from an oil tank when the oil being cold and thick, does not flow freely. In many places the fire-insurance companies compel the erection of an oil house at some distance from the manufacturing plant, in which the oil and other combustibles of like nature are stored.

As a means of heating such an oil house, so that oil may flow freely when drawn, a good method is to provide four lengths of 1½-inch pipe as shown in Fig. 1, and attach them to the back wall over the oil tank. The pipe feeding the coils should be ¼ inch in size, while the pipe draining the same should be of the same size. It will be found that by reducing the steam to one or two pounds by means of a reducing valve, that the oil house will be kept warm and the oil in a state for free flowing.

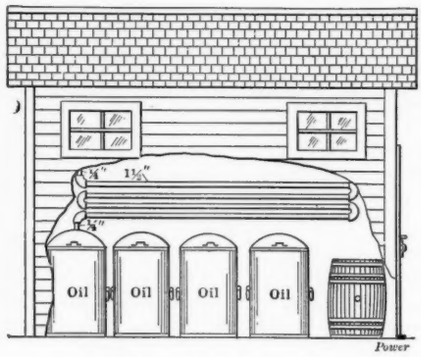


FIG. 1. OIL HOUSE

In Fig. 2 is shown a homemade pump recently seen in operation in a power plant, which answers the purpose very nicely and relieves the engineer from all responsibility and trouble of pumping oil into the oil reservoir.

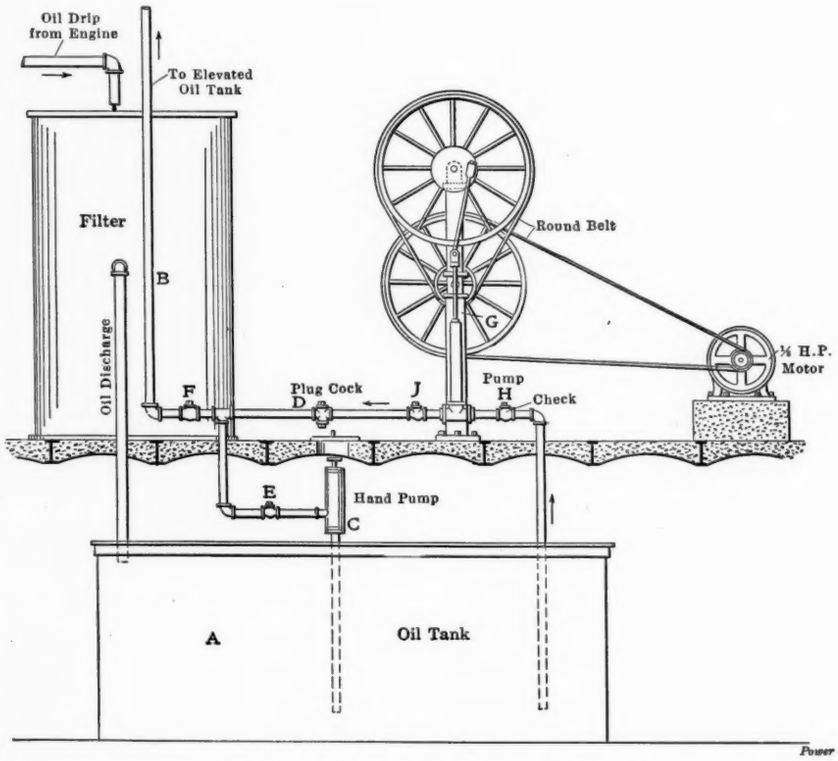


FIG. 2. OIL TANK FILTER AND PUMP

Another problem which has confronted the engineer is that of elevating oil that has been used on the engine, from the filter to the elevated tank supplying the oiling system. In many small plants, this has been accomplished by means of a hand pump, which is laborious work, especially when an engineer is limited for time.

In this case the oil from the engine returns to the filter, shown at the left of Fig. 2, where the oil, after filtering, passes into the oil tank *A*, by gravity; the oil flowing from the engine to the filter also by gravity. From the supply tank *A*, the suction pipe extends to within 2 inches of the bottom of the tank.

The pump is operated by means of a ⅙-horsepower motor, so speeded that the pump will just take care of the filtered oil to be delivered to the elevated oil tank feeding the engines, thus eliminating any bother on the part of the engineer of more than an occasional glance to see that the pump is operating.

It will be seen that the pump forces the oil in a direct line through the pipe *B* to an elevated oil tank, not shown. In case of accidents to the pump, or its failing to operate, the hand pump *C* has been provided and connected up as shown. For instance, in case the oil pump does not operate, the plug cock *D* is closed, the oil being then pumped by hand, the check *E* holding the oil in the pipe system. When the oil pump is ready to resume work the cock *D* is opened.

The frame of the pump *G* is made of 2-inch pipe having a special cap fitted to the top on which the bearing lugs for the upper wheel shaft are cast. This upper wheel shaft is fitted with a crank, which, by means of a crank rod, operates the pump plunger, the body of which is made of 1-inch, inside diameter, brass pipe, the checks *H* and *J* acting as valves for the pump.

The idea of having two large wheels belted as shown is so that a small motor may be used, the high speed of which requires considerable reduction in order that the pump may operate at the proper speed. The motor is belted from its driving pulleys to a large pulley on the pump, on which shaft a smaller pulley is keyed, which in turn is belted to the upper pulley driving the crank shaft.

This pump is such that one can make it from different supplies found about the ordinary steam plant, and is very effectual in its work, and will well pay for the time spent in its construction.

WILLIAM R. HUDSON.

Westfield, N. J.

Renewing Valve Disks

Probably other engineers have tried using sole leather for cold-water valve disks; I have and have obtained good satisfaction. The leather being soft, if the face, gets marred by grit, is made as good as ever simply by cleaning.

There is a nice thing about vulcanized asbestos disks; when they become worn out I can heat them and dig out the asbestos and pour in melted babbitt and scrape to a true fit, thus making them fit for further use.

I always have an extra disk on hand so when one wears out I replace it, and then babbitt the old one. I have not tried babbitt in Jenkins' disks but I think it would work all right.

FRANK GARTMANN.

Sheboygan, Wis.

SUBJECTS UNDER DISCUSSION

Comment, criticism and debate upon various articles, letters and editorials which have appeared in previous issues

Receiver Pressure in Compound Engines

In a letter by W. E. Crane, in the issue of January 18, some wonderful ideas are promulgated on the subject of steam temperature and cylinder condensation.

Comparing the opening of the rear door of a boiler setting for one second, with the intention of cooling off the furnace, and the opening of the exhaust valve for about the same length of time, he says that the cylinder will no more be exposed to the temperature of the exhaust pipe than is the boiler furnace to that of the outside air.

This statement is absolutely wrong, because it ignores the fundamental difference in behavior between a wet vapor and a dry gas. The gases in the boiler furnace may have any temperature, without regard to their pressure; steam in the presence of water can have but one temperature, that of the boiling point which corresponds to the pressure existing, and which is the first thing given in any table of the properties of steam. Merely to lower the pressure of the steam in the cylinder by expansion, without opening the exhaust valve at all, lowers the temperature of the steam and exposes the cylinder walls to this lower temperature.

Then there is the question of the condition or quality of the steam in the cylinder at the end of expansion. Mr. Crane unwarrantably claims equivalence between the operation of expanding against a piston and doing work upon it and that of free expansion or throttling, with no net or resultant external work by the steam. It may clarify ideas to refer to the steam turbine; when the jet of steam expands in the nozzle, it does work, not upon a movable confining surface as in the engine, but upon its own mass, changing heat energy into the kinetic energy of the jet. This diminishes the heat content and the steam partly condenses, just as much as it condenses, because of equal work done, in the reciprocating engine.

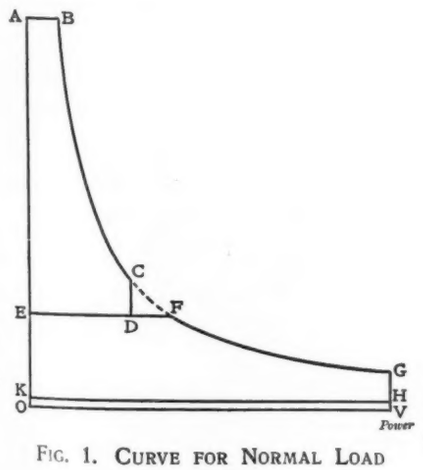


FIG. 1. CURVE FOR NORMAL LOAD CONDITIONS

If now the mechanical, kinetic energy is taken from the jet in work on the turbine blades, the steam remains wet, as does the exhaust from the engine. But if, instead of utilizing the jet, we let it come to rest in whirls and eddies, the kinetic energy changes back to heat and the steam has the same total heat, barring radiation, that it started with—not the same "temperature." It will be superheated above the saturation temperature belonging to the low pressure, but its temperature will be less than that which it had at the initial high pressure.

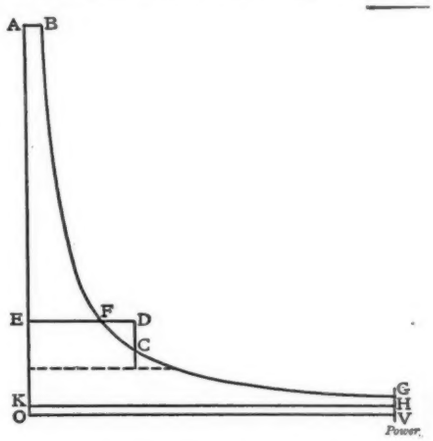


FIG. 2. CURVE FOR UNDER-LOAD CONDITIONS

Throttling or free expansion is the formation of the steam jet without taking out any work, so that the total heat remains. In the engine, the work done on the piston cannot possibly thus come back into the steam as heat. To claim that the two processes are the same shows a complete misunderstanding of conditions.

Mr. Crane's statements in regard to the nominal subject, receiver pressure, are so vague and confused that it is hard to know what he is driving at. In this connection, the writer would submit the following:

The simplified type of combined diagram used in Figs. 1 to 3 will serve very well to illustrate the discussion. It involves the assumptions of no clearance, perfect valve action with no losses in the steam passages, and a very large receiver volume; but actual conditions along these lines do not essentially affect the relations and changes to be considered.

The governing proportions are, boiler pressure OA, exhaust pressure OK, and cylinder volumes KH and ED. With these limits fixed, the amount of steam admitted and the power developed are determined almost wholly by the high-pressure cutoff at B. The division of this power between the cylinders depends upon the low-pressure cutoff at F. We assume that the expansion curve from B to G is continuous over or past the gap CF; then the steam which just fills the small cylinder at C will fill the cutoff volume of the large cylinder at F. An earlier low-pressure cutoff diminishes the volume EF, hence makes the receiver pressure higher.

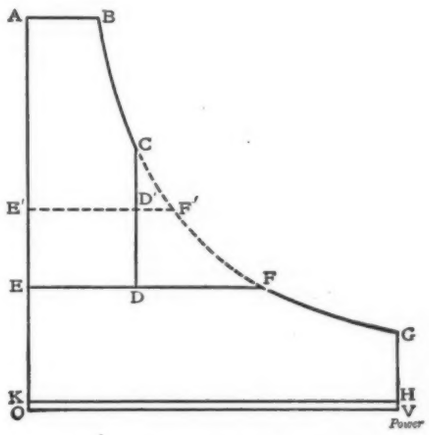


FIG. 3. CURVE FOR OVERLOAD CONDITIONS

With the idealized action represented by Fig. 1, the only loss of disposable work area is the little triangle CDF, due to what is generally called receiver drop. It does not pay to expand to the receiver pressure in the high-pressure cylinder any more than to expand to exhaust pressure in a noncondensing engine. It is better to use a smaller cylinder than would be required for complete expansion, and let the steam drop from C to D; but the drop must not be too great.

In proportioning an engine for its normal or rated load, the objects to be sought are:

First and perhaps most important,

equal division of work between the cylinders.

Second and incidental, nearly equal ranges of temperature in the cylinders.

Third, a moderate amount of receiver drop.

With the engine designed and put into service, the matter of receiver pressure is, for the operating engineer, a question of where low-pressure cutoff takes place and how it changes with governor action. Letting Fig. 1 represent normal conditions, consider

Light-load conditions are here illustrated.

If, as is usual with Corliss engines, the governor changes both cutoffs in about the same proportion, the low-pressure cutoff volume *E F* may become a good deal less than the volume of the high-pressure cylinder; this will raise the receiver pressure above the terminal at *C*, and the high-pressure diagram will have a loop such as is often seen in an underloaded simple engine. Keeping the low-pressure cutoff unchanged, as in most stationary slide-valve engines, will give the action shown by dotted lines which is decidedly preferable.

Overload conditions are represented by the diagram in Fig. 3. If the receiver pressure is kept down by lengthening *E F* with *A B*, the receiver-drop loss *C D F* may become very large. To raise the receiver pressure to *O E'* by keeping the low-pressure cutoff constant will give a much fuller diagram and it is probable that the thermal loss, in the way of greater cylinder condensation in the large cylinder, will be very small. The serious question is whether the low-pressure cylinder is strong enough to carry the increased pressure without bad effects.

The question of compound-engine proportions can be summed up in the following general statements, which are fully justified by experimental knowledge, and which put the matter on a simple and logical basis:

First, the primary object in compounding is to be able to use a high ratio of expansion without excessive thermal loss through cylinder condensation; but of almost equal importance is the mechanical advantage of avoiding a very wide variation of driving pressure throughout the working stroke.

Second, having adopted the principle of compounding, we can properly base the adjustment of proportions and conditions upon mechanical considerations as to pressure, force and work. If these matters are made right within any reasonable range of variation, thermal actions will take care of themselves.

Referring to Figs. 2 and 3, we see that to make the low-pressure cutoff change with the high-pressure, tends to keep the work division constant; while to hold the low-pressure cutoff nearly constant gives a better exhaust from the high-pressure cylinder. The latter scheme avoids the loop in Fig. 2 and the excessive drop in Fig. 3, and gives, on the whole, a much better receiver action—letting this term cover the entire operation of getting steam from the high- to the low-pressure cylinder.

It appears, finally, that there is some opposition between the regulation which is best for the machine in its journals and bearings and that which is best from the point of view of the indicator diagram. But if the low-pressure side can carry the greater share of a heavy load, that regulation seems preferable in which the receiver pressure rises and falls quite markedly with the load.

R. C. H. Heck.

New Brunswick, N. J.

Misleading Statements in Advertising Matter

The letter by William Westerfield in the issue of February 1, headed "Misleading Statements in Advertising Matter," calls for reply, as it is itself most misleading. The two statements to which he takes exception are, first, that "Exhaust steam will give up its heat faster to the radiating surfaces than will live steam from a reducing valve" and, second, that "This is one reason why you superheat steam for the engine, so that it will not give up its heat so readily to the cylinder walls."

Mr. Westerfield apparently believes that he has settled the first question when he says, "The best authorities agree that the rate of heat transfer depends upon the relative temperatures of the heating agent and the agent to be heated, no matter what they may be."

Mr. Westerfield should have regard to the beam in his own eye. The statement just quoted may be admitted, but only with this condition, other things being equal. In the case of exhaust vs. superheated steam, the things other than the relative temperatures are quite different, and his *obiter dictum* therefore has small value in the present discussion.

His statements about the manner in which superheat improves engine economy are equally unconvincing. He says, "If we superheat steam sufficiently to enable it to part with some heat without condensing on entering the cylinder, we avoid a considerable loss." It might be inferred from this, in connection with his previous statement, that the object of superheating is to provide more heat to be given up to the cylinder walls, but reasoning from Carnot's second law, we would venture the guess that improved engine performance with superheated steam is partly due to the greater temperature range provided for the working fluid.

As to the effect of superheat upon cylinder condensation I, also, beg leave to quote some "best authorities." The following is from a paper presented by Isherwood to the Institution of Civil Engineers in 1889:

"Wet steam—that is, steam from every molecule of which some *vis viva* had been taken; or, in other words, steam that had been subjected to partial molecular condensation as opposed to complete mass condensation—had the property of conducting heat in a marked degree, while dry steam, on the contrary, was practically almost destitute of this property. This kind of wet steam could only be produced by using steam expansively, and the more expansively it was used the wetter it was, and the wetter it was the greater was its power of conducting heat.

"Unexpanding steam was dry and transparent in a working cylinder throughout the whole stroke of the piston, suffering scarcely any condensation, no matter how great the difference between the temperature of the entering steam and the temperature of the exhaust or back pressure."

Now, it was exhaust steam expanded in a cylinder that the advertisement stated would give up its heat faster to radiators than would live steam superheated by passage through a reducing valve.

Confirming Isherwood's view, we also have the following by Michael Longridge, member of the Institutes of Civil and Mechanical Engineers:

"Superheated steam is, like a gas, a bad conductor of heat. It gives up heat slowly to dry metallic surfaces, and the surfaces radiate heat with difficulty through it. Consequently, in the time occupied by one revolution, the cylinder of a steam engine absorbs far less heat when it is kept dry than when it is bathed in a fog of saturated steam and water."

The main subject of the original advertisement, however, was not superheated steam and cylinder condensation, but rather a comparison of the action of the two kinds of steam in giving up heat to radiating surface, such as that of pipe coils. In regard to this, I beg to quote from a paper read before the Institute of Civil Engineers by F. H. Corson, describing tests carried out during a period of 12 months, with a final accurate test occupying 168 hours. Among other losses studied was that due to radiation from pipe lines, concerning which Mr. Corson says, "The condensation in the whole pipe system under these trials amounted to an average of 953 pounds of water per hour. This is equivalent to about 810,000 B.t.u. per hour, which figure divided by the total radiating pipe surface gives a heat loss of 473 B.t.u. per square foot per hour. It should be pointed out that the radiation cannot be quite correctly arrived at in this manner, for in practice the pipes carry superheated steam at a temperature varying between 450 degrees and 650 degrees Fahrenheit, while

in the test the steam was saturated, and probably very wet, at a temperature of about 380 degrees Fahrenheit. Several attempts have been made to estimate the quantity directly by observing the fall in temperature of a known weight of superheated steam passing through the pipes in a definite period of time. In a 72-foot length of 14-inch piping, it was found repeatedly that a flow of 16,000 pounds of steam per hour at a temperature of 580 degrees to 600 degrees Fahrenheit was accompanied by a fall in temperature of 15 degrees.

"The loss of heat in these experiments with superheated steam is

$$16{,}000 \times 15 \times 0.48 = 115{,}200$$

B.t.u. per hour, assuming the usual value for the specific heat of steam.

"The radiating surface in these cases being 306 square feet, the heat loss per square foot per hour is thus 376 B.t.u. From the experiments of Messrs. Knoblauch and Jakob, of the Royal Technical University, Munich, the specific heat of steam, at the temperatures and pressures employed, would appear to have a much higher value than is here assigned to it.

"If this higher figure be adopted, the heat loss mentioned becomes,

$$16{,}000 \times 15 \times 0.545 = 130{,}800$$

B.t.u. per hour or 427 B.t.u. per square foot per hour."

Now, to apply these figures to the statement of the advertisement, assume the boiler-room temperature to have been 90 degrees Fahrenheit. Then the difference between boiler-room temperature and saturated-steam temperature was 290 degrees Fahrenheit, which, divided into 473 B.t.u., gives a transmission from saturated steam of 1.63 B.t.u. per square foot per hour per degree difference of temperature, taking the average temperature of superheat as 590 degrees, the difference in temperature from steam to air is 500 degrees, which divided into 427 gives a coefficient of transmission of 0.854 B.t.u. per square foot per hour per degree difference of temperature. To apply these figures to the radiator problem, consider the room temperature as 65 degrees. Then the difference in temperature between saturated steam in the pipes and the air of the room would be 147, which, multiplied by 1.63, gives a transmission of 239.5 per square foot per hour.

Now, consider the radiator supplied from a main carrying live steam at 20 pounds, which is reduced through a reducing valve to atmospheric pressure. The resulting temperature would be 247.7 degrees Fahrenheit, giving a difference above the air of the room of 182.7, which, multiplied by 0.854, would give a total transmission of only 155.9 B.t.u. per square foot per hour.

Mr. Westerfield should exercise greater care in looking up his facts before he condemns statements as misleading, for as he truly says, "Inaccuracies recoil upon their authors to fill them with dismay."

GEO. H. GIBSON.

New York, N. Y.

Position of Throttle

In the January 18 number, Oakes Kyger objects to having the throttle wheel over the back cylinder head because with a Corliss engine one should stand on the valve-gear side of the engine.

If Mr. Kyger will place his wheel as indicated, he will find that it is more convenient than if located in the usual place, the only difference being that in some instances, he may find himself standing at the end of the starting bar instead of at the side.

The important thing is that the wheel can be reached easily from either side of the cylinder.

W. E. CRANE.

Duluth, Minn.

Trouble from Seaweed

Noticing several articles lately regarding trouble caused by seaweed where water is taken direct from the sea for circulating through condenser, I would like to explain how I overcame this trouble.

When taking charge of a plant located on the seashore, I found the suction pipe of the circulating pump lying on a pier and extending out to sea about 700 feet, as per sketch, Fig. 1, supported on piles and open at the bottom. This caused no end of trouble, for the suction pipe would draw in anything in the vicinity of several feet, choking the pumps with kelp and

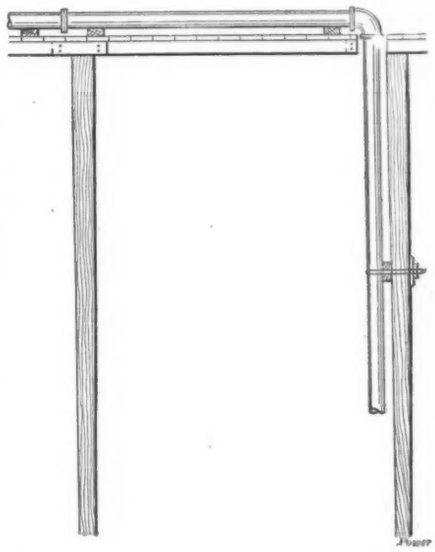


FIG. 1. SUCTION PIPE OF CIRCULATING PUMP

miscellaneous other stuff. I took measures to overcome the trouble in the following manner: I ordered a cast-iron swivel joint and a screen. The screen was 36 inches in diameter and 6 feet long with an opening in one end to fit over the end of the pipe and fastened by a clamp.

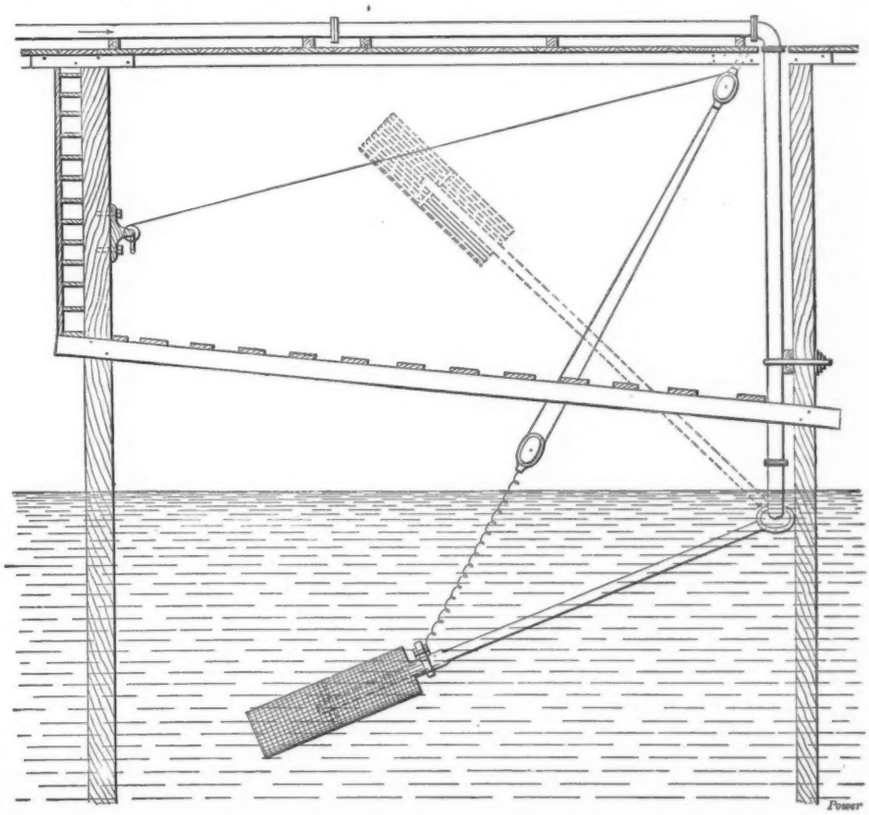


FIG. 2. IMPROVED ARRANGEMENT OF SUCTION INLET

The screen was made of No. 6 hard-drawn copper wire, ¼-inch mesh, and to keep it from collapsing it was built over a skeleton frame made of ½-inch by 1½-inch galvanized iron. A windlass was erected and a platform built under the pier. The arrangement looked as per sketch, Fig. 2, and cost about $400. This screen being about 8 feet under water could be inspected any time, and was cleaned once a week. The cleaning required the work of two laborers ten minutes. When screen was to be cleaned it was brought up over platform by means of the windlass and thoroughly cleaned in a few minutes by throwing off the kelp and seaweed by hand and brushing with a steel-wire broom kept for the purpose.

When taking water direct from the sea with an arrangement of pipes and screens there is still another difficulty to be over-

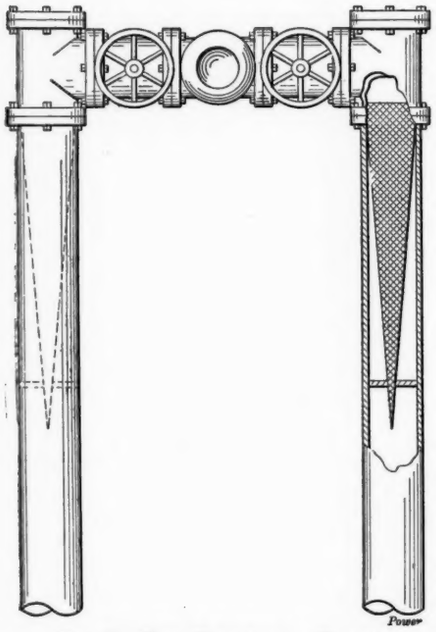


FIG. 3. THE CHANGE IN PIPING

come by the engineer. That is barnacle growth inside of the suction pipe. After about six months I found two lengths of pipe and the swivel joint filled with barnacles and marine growth. The area of the pipe was reduced fully 60 per cent. welded several 1-inch carpenter's chisels into the ends of ¾-inch gas pipe and shaved the barnacles from the inside of the pipe in short order.

But as this cleaning out of pipe had cost labor and material, and would probably have to be repeated every 6 months I changed my piping as per sketch, Fig. 3. Inside of each downward leg or branch is a screen made of No. 6 hard-drawn copper wire, ¼-inch mesh. This screen, 10 feet long, is cone shaped, is fastened in the tee with a brass ring and studs, and terminates in a point. Two feet from the point of the screen there is a guide to hold it in the center of the pipe. Now when screens are to be cleaned it can be done without losing the circulating water by shutting one of the gate valves and pulling the screen out of pipe for cleaning. With this arrangement we overcame entirely the trouble from seaweed and barnacles.

H. NOLTHOFF.

Los Angeles, Cal.

Engine Cylinder Can Act as Pump

As evidence of the fact that a steam-engine cylinder can act as a pump, I will tell of my experiences. In 1898, when I was working on a logging railroad near here, whenever we had occasion to shift a dead locomotive we usually had a man in the cab to handle the reverse lever so that the dead engine would not act as a pump and pump air into the boiler. Several times when we did not throw the reverse for the way we were going, enough air pressure was developed to stop or nearly stop the live engine.

Once, while doing some work on a stationary slide-valve engine when there was no steam in the boiler, I could hear the air gurgle through an open valve near the boiler when I turned the engine over by hand. After these experiences, I cannot see why a plain slide-valve engine, run by outside power, would not pump water as well as air if there was water in the exhaust pipe.

ROY B. STEARNS.

Hartford, Wash.

Kerosene in Boilers

The recent discussion in POWER on the use of kerosene in boilers, brings to my mind an incident which happened about four years ago in a mill in Fall River, Mass., where a fireman was badly injured due to the use of kerosene as a scale remover. The accident happened while the plant was shut down for boiler inspection. The inspector had just finished inspecting No. 1 boiler internally when he called the assistant engineer and told him to get some kerosene in a large pail, take a dipper, and sling the kerosene around inside the boiler. The young fellow filled up a five-gallon can, and threw about two gallons of oil around inside the boiler; after this he went down in front of the boiler to replace the handhole plate.

About this time the inspector came out of No. 2 boiler, and seeing the kerosene and dipper standing on No. 1, he called a fireman over and taking the dipper commenced showing him how to sling the oil around inside the boiler. After throwing two or three dipperfuls, he allowed the dipper to accidentally slip out of his hand into the boiler. He told the fireman to go in the boiler and get the dipper. This the fireman at first refused to do, but finally when the inspector insisted he entered the boiler, taking the inspector's candle along with him. He had been in the boiler but a few seconds, when all of a sudden the whole inside of the boiler was on fire.

There was an awful racket for about one minute, with the screams of the fireman inside the boiler, the crackling of the fire and the yelling of the inspector who was trying to direct the poor fellow to the manhole. After a short time, the fireman came within the inspector's reach and the latter immediately lifted him out. The poor fireman certainly was a sight. He was laid up in the hospital for a long time. When he commenced to get around again it was found that he would not be able to use his hands very well, because all his fingers were drawn together, so he was going to sue either the mill people or the insurance company. He secured a settlement, however, without taking the case to court.

FRANCIS CHEGG.

Taunton, Mass.

In the January 11 issue Mr. Horsfall advances some new theories as to the action of kerosene in boilers and gives us a brand new idea as to the manner in which kerosene loosens scale.

While he defines correctly the flash point of oils and gives the range of kerosene from 110 to 150 degrees Fahrenheit, he assumes the flash point and the vaporization point to be one and the same thing. Taking this assumption as the basis of his claims, he then says that if the oil is fed into a boiler while getting up steam it will have all passed into vapor before the water in the boiler has even reached the boiling point.

In any oil there are three critical points, viz., the flash, burning and vaporization points. The flash point is the temperature at which oil discharges by distillation, vapors which may be ignited by passing a lighted match about a half inch above the surface of the oil. The burning point is the temperature at which the whole surface of the oil will be ignited by passing a match as in the flash-point test. The vaporization point is the temperature at which all the oil will pass into vapor and corresponds to the vaporization point of water. This last temperature is the one which should have been used in the article under discussion and is in the neighborhood of 340 degrees Fahrenheit at atmospheric pressure or about 125 to 130 degrees higher than the vaporization point of water.

As Mr. Horsfall's whole theory depends on having the oil vaporize at a lower temperature than the water, we are forced to take exception to his statements and must believe that whatever effect kerosene does have on scale is accomplished in a different manner than that described by him.

HARRY KAHN.

New York City.

The Development of Power Systems*

Some of the More Important Natural Laws and Physical Processes Applied in Power Systems for Transforming Natural Forms of Energy into Useful Work

BY CHARLES EDWARD LUCKE†

In the story of the development of machinery, the part played by rods, shafts, cylinders and other elements of the mechanism, is subordinate to the conceptions of physical processes which each arrangement of parts is devised to carry out. It is more important to know just how steam should be treated in order to obtain the most work, than to be able to make a steam engine that will run; it is more important to know how a combustible gas mixed with air should be treated to give an explosion producing the highest possible pressure, than to be capable of making a chamber strong enough to withstand the effects of the explosion. Each process as it is conceived adds a fact to man's understanding of nature and in turn contributes to the discovery of the next.

Air and water in motion being capable of moving wheels with paddles naturally leads a student to inquire how fluids may be put in motion; a question which once conceived almost instantly answers itself—by allowing them to escape from high-pressure chambers. The next logical inquiry is, how may fluids be prepared so as to be under high pressure in chambers from which they may escape? This leads to the discovery that water may be boiled in closed vessels and that explosions of powder or gaseous fuels may be caused, resulting in the desired high pressure, or more simply, water may be led in pipes from the upper level of a falls to the lower, and at once the three characteristic systems of power generation are understood.

An almost infinite number of combinations of mechanism parts can be found to carry out each process. The processes are fundamental, the mechanisms, incidental. It must not be assumed, however, that the parts may have infinite variety of form or that they may be made of any material, for there are limitations which cannot be ignored. The elements must have such simple form that they may be easily made by the workmen. Both the form and material of each part must be suitable in strength, stiffness, flexibility and wearing qualities. The whole machine must not be too costly to produce nor to keep in repair and it must not require too much skill on the part of the operator.

The problem of power-machinery development is divisible into several parts:

First, What processes must be carried out to produce motion against resistance.

Second, What combinations of simply formed parts can be made to carry out the process.

These two parts when worked out will result in some kind of an engine; but it may not be a good engine for it may use up too much natural energy for the work it does; some part may break or wear too fast, another may have a form that no workman can make, or use up too much material or time in the making; in short, while the engine may work, it may do its work at too great a cost, in coal or water, in attendance or in investment. There must, therefore, be added other elements to the problem.

Third, How many ways are there of making each part, and which is cheapest? What other form of part might be devised that would be cheaper? What cheaper material is available which would be equally suitable?

Fourth, How sensitive to care are all these parts when in operation and how much attendance and repair work will be required to keep the machine in good operating condition?

Fifth, How big must the important parts or the whole machine be to utilize all the energy available or to produce the desired amount of power?

Sixth, How much force must each part of the mechanism sustain and how large must it be when made of suitable material so as not to break?

Seventh, How much effective work can the machine do for each unit of energy supplied?

In the early days of power generation all these elements were not recognized. They were developed and studied about in the order named; a fairly satisfactory solution of the first parts pointed out the existence of those that followed and the necessity of studying them. The solution of a new question reacted on an older one so that new solutions of the older question appeared which could not be conceived before. Systematic study of engineering problems has been receiving attention for about a century and a half, but has been divided into periods as the study advanced to the higher stages. For example, it was not until about 1860 that the seventh element of the problem was successfully treated for those power systems depending on the heat of fuel as the source of energy. Although successful and commercially valuable steam engines had been continuously produced for a hundred years, no one was able to calculate exactly how much of the heat in the steam might be converted into work by a mechanism ideally perfect, so that the goodness or badness of a given engine could not be judged by scientific standards, but only in a comparative way. One machine might produce a horsepower with less coal than another but no one could state positively why, which, of course, is the first step in rational improvement of economy. But the minimum possibilities of coal consumption for a given system could not be calculated, hence, the comparative value of competing systems could not be judged. This sort of calculation is now an everyday thing which every engineer is capable of carrying out and is the basis of all modern designing and improvement. The fact that it took over a hundred years after building useful engines to arrive at a scientific conception of the fundamental processes which were being more or less imperfectly executed in machines designed largely by rule of thumb, is doubly significant of the high order of mental development necessary for it when it is realized that the first and second elements of the problem were understood to a degree sufficient to enable men to produce working models some two thousand years before.

The period of systematic and scientific power development is coincident with true progress in the most basic of the several branches of natural philosophy, of chemistry, physics, mechanics, thermodynamics and the theory of elasticity of materials; and there is no doubt that the steam engine, which was built by mechanics before basic laws were well understood, attracted the attention of philosophers who, in attempting to explain what took place in it, created a related body of principles by which future development was guided. Those men who became familiar with natural science and also with shop methods of making machinery and who brought their knowledge to bear on the problem of the production of machinery for specified conditions, combining the special knowledge of the scientist with that of the shop mechanic, were the first mechanical engineers; and the profession of mechanical engineering which is the term now applied to this sort of business was created out of efforts to improve power systems so as to make them more efficient and better adapted to various classes of service.

Nothing is more interesting than the

*Abstract of second Hewitt lecture delivered February 14 at Cooper Union hall, New York City.

†Professor of mechanical engineering in Columbia University.

detailed history of power-system ideas, mechanism and the production of both the machinery and the power itself, studied along with the parallel development of the natural sciences. But this is beyond the scope of these lectures in which no more than the merest outline can be attempted, just sufficient to permit of a little understanding of modern machinery.

As has been already said, one of the earliest understood ideas applied to power generation is that water in motion may, by striking paddles on wheels, move them, and itself lose some of its motion, or that the energy of motion can be communicated from one body to another. One of the earliest kinds of wheels was hung by its shaft, which was just a log of wood, over the surface of a fast-moving stream at such a hight as would allow the paddles to dip into the water. The idea involved, old as it is, is one of the most modern inasmuch as it is basic to the largest modern water and steam turbines. It must not be understood that the basic idea consists in the dipping of paddles into a brook; this is a mere incident, a convenient way of making use of the real, fundamental principle that the energy of moving fluids can be imparted to wheels by bringing the fluid to rest in a suitable way.

In most of the modern turbines, which is the name applied to the highly developed forms of wheels designed to rob moving fluids like steam and water of their energy of motion, there are involved many other principles, some of which are very old and some of recent conception. One of these, easy to understand, is concerned with the way in which water may conveniently be set in motion. Water led from an elevated tank or pond by pipe to a lower level exerts a pressure tending to burst the pipe which is more powerful the greater the drop, and the greater the pressure is the greater the velocity of the water flowing from the nozzle. Similarly, water, steam, air or any other fluid, existing in a chamber under pressure, will escape from that chamber through a nozzle in a jet which will have a velocity determined by the pressure. The quantity of fluid that can escape, as well as the energy of the jet, will depend on the size of the hole and velocity of the jet. It has always been found more convenient because of the concentration of energy that results, to devise means of getting the fluid under pressure, and then allowing it to escape in order to give it motion instead of depending on fluids naturally in motion. Jets of fluid may be allowed to play on vanes or paddles in a great variety of ways, giving different types of motors all known by the class name of impulse wheels. Some have one nozzle and others many; the arrangement and form of vanes vary greatly.

It required many years of experiment, calculation and comparison to discover just what curvature and angle should be given to vanes and nozzles to secure high efficiency, for while almost any combination will run there is only one best design and the determination of that best design is the principal problem of the engineer today. To such perfection has this work been carried that it is now possible to predict within 1 or 2 per cent. how much of the fluid energy a turbine, yet unbuilt, will be capable of transforming into useful work. A proper relation between the speed of the vanes, that of the steam jet and the angles and curvature will allow the steam to leave with the lowest practical velocity, most of its original energy of motion having been imparted to the wheel, and these things can now be determined with precision. When the water issues in a fast-moving jet from a nozzle, the nozzle is pushed backward, just as a gun recoils as its projectile moves out, and this principle of reaction is used in both water and steam turbines, either alone or associated with the impulse action. To all wheels in which the reaction of the jet rather than the impulse of its striking the vanes exerts the driving force the class name of reaction wheels is applied.

The antiquity of the reaction and impulse principles is shown by the records in which it is said that one Hero, 200 years B. C., made a steam reaction turbine, in which a fantastic water vessel was heated by a fire, making steam which, flowing up two vertical standards, hollow like pipes, entered a ball arranged to rotate on the ends of the standards. From the ball the steam escaped by nozzles tangentially, causing the ball to spin, to the mystification of the mass of the people, who believed that some spirit from the other world had been brought under command. A later, but nevertheless old device, dating from 1629 and credited to Branca, an Italian, is a pure impulse steam turbine, coupled by tooth gearing to a shaft with lumps on it arranged to lift pestless for crushing corn or ore.

The simplest, oldest and at once the most modern ideas for power generation are then:

First, a moving fluid properly directed may move wheels against resistance when it strikes vanes suitably formed and arranged.

Second, a fluid under pressure may acquire motion simply by escaping.

Third, jets of fluid escaping from nozzles or suitably formed passages in wheels may by the reaction of escape alone turn those wheels.

To these principles, minute and painstaking investigation guided by progress, which no doubt assisted in stimulating as well, in mathematics, mechanics, physics and chemistry, there has been added a vast body of engineering principles by means of which true design can be carried out, and turbines built of predicted efficiency and of proper strength in all parts.

It is a most significant fact that although Hero produced a rotative steam engine, that worked, in 200 B. C., nearly two thousand years elapsed before the first commercial rotative steam engine was produced by Watt about 1780, and that after him the progress of about seventy years in power-system development resulted in advances which entirely eclipsed all the progress made since Hero's time. There are good reasons for this and the key is to be found, first, in the lack of demand; and second, in the lack of information to enable makers of machinery to meet demand when it came. Practically all the power machinery produced before the time of Watt in 1780, except special devices adapted to pump water only, was more the result of accident than of logical reasoning from desired results to means by which they might be attained. Even after Watt much that was done was prompted by a desire to do something different, a groping after something by trying everything. There was no conviction based on proof or established principles that the means were right or best. This is pure invention without which, it is true, little progress is possible. A conception that the new thing must produce the desired result in a truly better way or produce a new result superior to the old with no more wasteful means, becomes possible only when there is available a body of facts and principles related to each other and so constituting a science by means of which existing machinery can be analyzed to reveal all faults and their causes and the performance of new machinery yet unbuilt can be predicted with reasonable certainty. This is true design, without which invention alone may result in nothing more than interesting toys. But when combined with invention, design gives the engineer command over nature. The basis of engineering design is knowledge of facts and principles, so it is easy to understand why in the early days of engine building no true design was possible, for the machine and its operation themselves supply the means for collecting the necessary facts, and mental capacity, however well trained, cannot find the relation between the facts until the facts themselves are found by tests of the machinery. Once discovered and classified, these relations constitute a body of principles having the force and dignity of laws of nature, the discoveries and application of which to the uses of men constitute the profession of engineering.

Careful inspection of steam boilers when they are in the process of construction is quite as important as periodic inspection when they are in operation.

Newton's Law Suspended?

What do you think of the morals of an ordinary india-rubber ball that will remain in the air without any visible means of support, and will change its position at a simple beck of the finger or a pass of the hand? It sounds like witchcraft or magic, doesn't it? We know of such a ball, and the least we can say is that we thing it highly indecent of it to treat Newton's law in such a cavalier manner. It only obeys the law occasionally; when it chooses, so to speak.

Newton's law is a perfectly good and wise decree, which dictates that all bodies, human and otherwise, shall fall to the earth. Not only that, but it prescribes the manner in which each shall fall and at what speed. We all have had the experience of "getting up in the air" at one time or another, and we know that the higher up we got, the harder the shock was when we "got back to earth."

Now, here is this insignificant rubber ball refusing to act even humanly. The ball weighs about ½ ounce, and is 4¼ inches in diameter. It is filled with air, not with a gas lighter than air.

Fig. 1 is a halftone from a photo taken while the ball was "acting up." Yes, the fan is there. No, we don't deny that the fan is blowing at the ball. In fact, we are anxious to call your attention to this, else we would have omitted the fan from the picture. The very fact that the fan blows at the ball at an angle of very nearly 45 degrees to the vertical, makes the action of the ball all the more curious to us. When the fan is in the position shown in Fig. 3, the action of the ball is not so startling, as we all are familiar with this phenomenon as illustrated by the glass ball and stream of water displayed in shooting galleries.

The curious behavior of the ball was discovered by some genius in the experimental engineering department of the American Blower Company. The outfit which we used to make our investigation was one belonging to that company. It was a standard "Sirocco" blower, size 00, direct connected to a compound-wound motor operating on current from an ordinary incandescent-lamp circuit at 120 volts pressure. The motor consumed one-fortieth horsepower. The fan wheel is 3 inches in diameter, 1½ inches wide and has 36 curved blades, 3/16 inch wide. It ran at a speed of 2700 revolutions per minute. The fan delivered 85.7 cubic feet of air per minute at a velocity of 51.4 feet and under a velocity pressure of about 0.7 inch of water at the outlet.

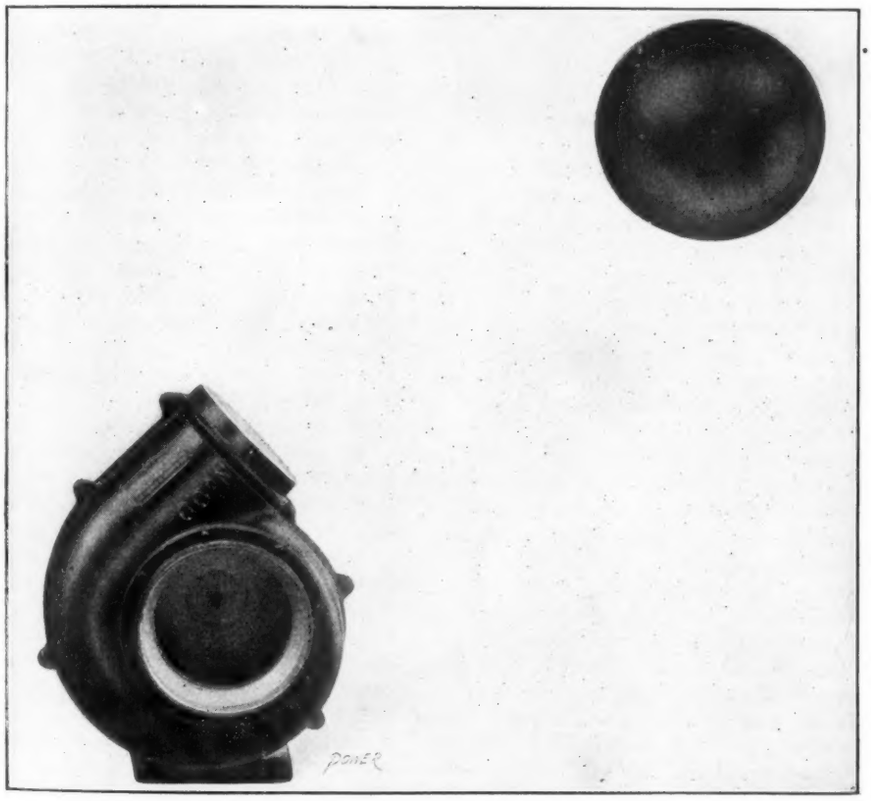


FIG. 1. OUTLET AT ANGLE OF 45 DEGREES

When the outlet was at an angle of approximately 45 degrees, the ball stood about 12 inches away, but when the outlet was in a vertical position, as shown in Fig. 3, the ball stood about 8½ inches

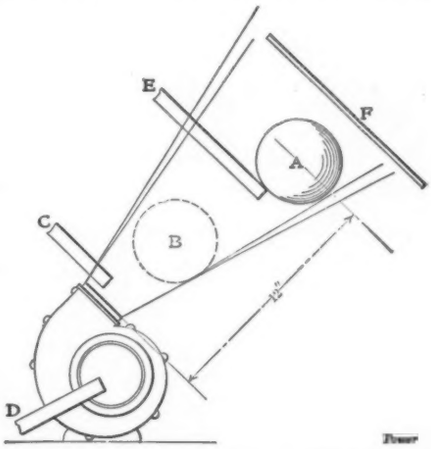


FIG. 2. DIAGRAM SHOWING POSITIONS OF THE BALL

away. In other words, the ball stood in the same horizontal plane whatever the angle of the outlet. When the current of air was discharged at an angle, the ball would not stand in the center of the stream, but took a position close to the lower boundary, as indicated at *A*, Fig. 2.

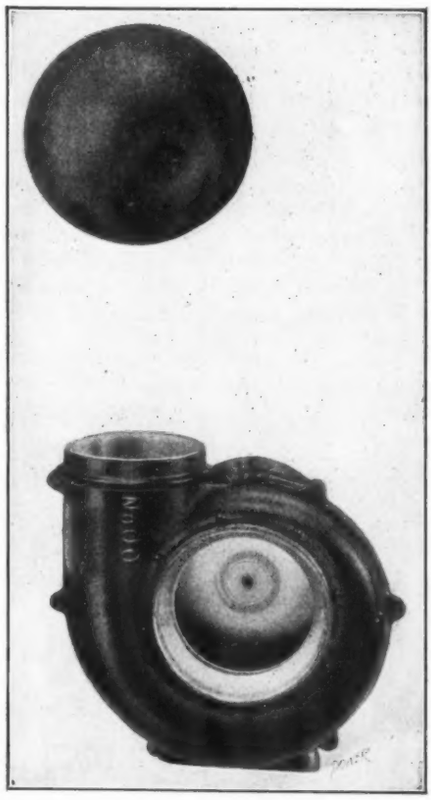


FIG. 3. OUTLET IN VERTICAL POSITION

By placing the hand or a piece of cardboard behind the ball in a position such as is shown at *F*, Fig. 2, and pressing it down toward the fan outlet, the ball could be made to move down stream, but would always stay about 2 inches way from the hand or object behind it.

If the strength of the air current was cut down by placing an obstruction in the outlet, as at *C*, or the inlet, as at *D*, the ball would drop down stream, as at *B*. The distance it would come down would depend upon the amount to which the current was weakened.

If an object the size of the finger were placed in front of the ball, as at *E*, and then moved toward the outlet, the ball would stick to it and follow down stream.

These things are curious.

What is your guess as to why the ball is not blown away instead of being held in the position shown in Fig. 1, when the air current is directed at it from one side? Why does the ball act as it does when subjected to the experiments we have described.

Perhaps the ball is justified in acting in a manner which at first blush seems contrary to the order of things.

More Information on Rhode Island Coal

Discussion on the Papers Presented by Henry M. Whitney and Henry J. Williams before the Boston Meeting of the Society of Chemical Industry.

We concluded our partial report of the Rhode Island Coal meeting of the New England Section of the Society of Chemical Industry by an announcement that Mr. Williams' paper and the discussion would appear in another issue. We thought that we were warranted in doing so, having obtained both the approval of Mr. Whitney to its publication and Mr. Williams' promise of a revised copy. In response to a telegram asking that it be mailed we received the following:

"Your telegram received. Mr. Whitney wishes me to inform you that, as the attitude which you have taken in your paper, in regard to Treated Rhode Island Coal, has never been either friendly or fair, we do not in any way feel called upon to let you have the paper referred to for publication.

Yours very truly,

(Signed) HENRY J. WILLIAMS.
Expert on Coal."

This is our apology for our failure to keep a promise made, it is true, a little overconfidently in view of our experience with Mr. Williams in the matter of an opportunity to test his treatment, which opportunity it was promised on October 20 should be afforded "in a week or ten days," and which has not yet materialized.

DISCUSSION

After the conclusion of Mr. Williams' paper, Dr. W. H. Walker, who presided, declared the subject open for discussion.

Dr. A. H. Gill. I have not heard the explanation of the subject for which I came. We have had an explanation of the action of sodium nitrate, which I am sure is new, and founded on a fact which Mr. Williams discovered. He has not explained the action of calcium chloride. That is a matter I should like to have explained.

Mr. Williams. I might explain it in this way, as near as it can be explained in the present state of our knowledge. I showed in reactions 1 and 2* that the catalytic action of sodium oxide in reaction 1 reappeared in reaction 3 without change, thus conforming exactly with the definition of a catalytic agent, which I stated here as "a body which produced chemical changes in another, apparently by mere contact; while a catalytic force is a power seemingly possessed by some bodies to produce changes in others without themselves undergoing permanent change." It is impossible to say what form the body has got to be in before it begins to act catalytically. You may start with something else; you might start with sodium sulphate, but it is not the sodium sulphate which acts catalytically. Something remains there which acts catalytically. Now, if we take any lime salt, it does not make a particle of difference whether we have the calcium chloride present and it stays calcium chloride throughout and produces the result, or whether it undergoes a chemical change, and what is left there does the catalytic work. All we know so far as we have gone is that where calcium chloride is used, we get precisely the same result, so far as burning the carbonic oxide is concerned. The only thing you can do in a case like that is to assume that some similar catalytic action takes place with that calcium chloride. It is impossible to say exactly what that chemical change is, but there are two or three possible changes which it seems reasonable to assume explain the reaction. Supposing the calcium chloride undergoes a change, and gets converted into calcium oxide, and the calcium oxide being present in a particle of treated coal, in contact with intensely heated graphitic carbon is in the same condition as any oxide would be in a blast furnace, where reduction is likely to take place. We will assume that that carbon will reduce the calcium chloride, and will be the chemical agent of the oxygen, setting free carbonic acid. The calcium being an element which cannot exist by itself very well, being very susceptible to oxidization, the moment that reduction takes place there seems to be a taking up of the oxygen, being reformed at once. It seems to me possible that, assuming the calcium oxide present, we may have the surrounding oxygen set free from any oxygen of the air. The next particle is set free, and that goes on indefinitely and is repeated through all parts of the fire. Now, supposing this does not take place at all and we are dealing with calcium chloride alone, I made a number of experiments in order to find out, if possible, whether the calcium chloride undergoes a change. I treated some coal, and placed it in a long tube, coal which had been treated with calcium chloride, a 2 per cent. solution, and dried the coal, so as not to be disturbed by the moisture. This was placed in a combustion furnace, heated very hot, connected with a solution of caustic soda, the idea being that if the calcium chloride gave up its chlorine, it would be caught in the water. I carried on this experiment for three hours and a half at the highest temperature I could get in my furnace, and I could not get a trace of hydrochloric acid. As far as that experiment goes, it would seem to indicate that the calcium chloride does not undergo change, and hydrochloric acid is not given off and does not escape. The only explanation is that it might be partially given off, and something in the coal would partially retain it. Be that as it may, my experiments have not gone far enough to tell me any more than that I believe it does not undergo a change, and if it does not undergo a change, you can still explain the probable reaction in this manner. The formula for bleaching powder is somewhat uncertain. It is given as CaCl or CaClCl. With whichever formula you take, the minute you treat bleaching powder with water, you get a mixture of calcium oxide and calcium chloride. That being the case, assume your particle of

*See "Chemical Aids to Combustion," POWER, February 15, page 329.

coal is treated with calcium chloride. It is perfectly reasonable to suppose that the oxygen of the air can go in there temporarily and form that compound, and hand it over to the carbon and set free carbonic oxide; another one go there and get some more, or you can take the other form, and have the oxygen go in those two places. Either one of those reactions is a possible reaction. Now, whether that takes place or not makes no difference. We do know that carbonic oxide is produced in enormous quantities, and produced for hours. Personally, I do not care whether my theory is correct or not. I know we are obtaining the results; we are going to utilize them, and that being the case, we apply these results to our coal, and make it burn where nobody else has been able to make it burn before. Does that answer your question, Mr. Gill?

Doctor Carmichael. I would like to ask whether in your experiment with the tube you dried the air you had pass over it, or whether it was moist air.

Mr. Williams. It was dry.

Doctor Carmichael. May that not be the reason you got no chlorine?

Mr. Williams. That may be. Where you have a large mass of fuel intensely ignited, and of carbonaceous matter, you pass air through it, and you get the decomposition of moisture which has been suggested, your hydrogen and oxygen. The oxygen combines with the carbon, givng carbonic oxide. You produce water gas. Now, it seems to me perfectly reasonable to suppose that if you have calcium chloride present under those identical conditions, you may have nascent hydrogen and nascent oxygen, both of which act very much more vigorously than assorted salts, and I should judge the nascent oxygen might act under those conditions, in setting free CO gas through the medium of the calcium chloride, where it would not take place if those gases were simply by themselves. Of course, the quantity of chemical which you have to act upon, from the explanation which I have given, with the quantity of solution is so infinitesimal that your percentage is away down in the hundredths of one per cent., and being so small the moisture in the natural atmosphere itself seems to me quite capable of going through such reaction as that, so that you may have the nascent gas free to act. If that is the case, that reaction would be explained.

Henry Howard. I will ask how sea water works.

Mr. Williams. Salt will work in the same way, but with this addition, that the salt itself is volatile, and will not remain in the fire long enough to cause any appreciable result, but your trace of impurities, your lime and magnesia, will act catalytically. It will act, but the proportion is so much less in sea water than any of the salts that we employ that it is not advisable to use it. You do not want to be bothered with the 200 or 300 per cent. of salt which there is, with the small trace of other material. It would simply go up the chimney and do no good. As a matter of fact, I have explained that the coal which contained lime when it was wet would burn, as Professor Silliman and the doctor that I mentioned said, probably according to this catalytic action. That expains how, occasionally, Rhode Island coal seems to burn satisfactorily. The process which we apply simply brings the uncertainty of the coal burning once in a while down to a dead certainty, so that it always behaves itself. We have never had a failure yet. The difficulty in proving these facts absolutely is that frequently we get hold of coal which happens to have a lot of lime in it, and put it in the stove without any treatment whatsoever, and it happens to burn and burn pretty well, and then people say we don't know what we are talking about, and the whole business is a fake. As a matter of fact, the sample of coal which was the first coal I had occasion to use, when put into the fire, would give flames which would last an hour; then they would disappear, and you would not get any more. Then we treated that coal, and we got flames two or three feet long.

A. D. Little. I would like to ask Doctor Williams why his process is not substantially anticipated by the long-continued experiments of the British Admiralty, in storing coal under sea water, and afterward burning it.

Mr. Williams. I am not particularly familiar with those results. I have not studied them. I know they have taken place. Have they shown substantially that the treated coal would burn better; or that the coal which had been under water would burn better?

Mr. Little. No.

Mr. Williams. I should attribute that to the fact that the sea water was so weak in the salts it did not act with enough vigor to give satisfactory results. The quantity of chemical which we use, although very small, is still an appreciable percentage. A 2 per cent. solution will give you practically 0.15 per cent.

Mr. Little. Is your process applicable to soft coal?

Mr. Williams. It is perfectly applicable to soft coal, with this difficulty, that one of the necessary conditions of the reaction to take place is that a high temperature should be maintained. Just as soon as you apply it to soft coal, the minute you put fresh coal on your fire, and cool your furnace by the volatilization of your volatile matter, the action of the chemical stops. If you can only keep up the temperature of the furnace, the volatilization goes on, and you get your results. I had occasion to make a series of tests in Springfield. I treated 300 tons of Moshannon coal, which contained 22 per cent. of volatile matter. This test was conducted in the summer time, when the coal was exceedingly dry. This particular coal contained only about 1¾ per cent. of moisture, and I took the precaution, instead of adding 6 per cent. of moisture, of adding a solution which contained the equivalent of 2 per cent. of moisture, only. That coal was burned continuously for three days and three nights with mechanical stokers, and in all that time we did not have any production of smoke for periods exceeding one minute at a time, while with the untreated coal there was a stream of smoke which was almost continuous, under the same conditions. Those same experiments were repeated at the Harvard power station of the Boston Elevated Railway, in the winter time. There I had to take such coal as they furnished. They furnished me a Pocahontas coal, which had been exposed in the yard for 14 months, and which was very irresponsive. In consequence, it did not burn satisfactorily at all. Moreover, it was excessively moist. It had 7½ per cent. of moisture originally, and I added 2 per cent. moisture on top of that. When the coal was put on the fire, it stuck together, and could not feed through the mechanical stoker continuously, and it would cling, and then it would come in a great bunch of wet coal, and cool the fire, and naturally the action stopped. That did not prove that the theory of it was not perfectly correct. It simply showed we were dumping a lot of wet, cold coal on the fire, and that the volatilization of the volatile matter and the moisture was simply cooling the furnace below the temperature necessary for the reaction to take place. Naturally it stopped. If you maintain the temperature of the furnace, you won't have a particle of trouble to get your results.

Mr. Stantral. In a good many cases, the temperature of the fire in household work goes below 1200 degrees?

Mr. Williams. There will be a few cases where there will be a few lumps. It only takes a few moments for the temperature to start a small amount of gas. By producing that gas, you warm up other lumps, and these fires of Rhode Island coal have this peculiarity, that you may have a tremendous fire with flames two feet long. You can shut it down until the flames disappear altogether. It will hold the fire. You can put on the drafts, and have flames two feet long again. That has been done right along. In the station at Portsmouth, the station agent has been using in his stove Rhode Island treated coal all through the last winter, and has had most satisfactory results with it. It has always responded to the drafts, and produced these long flames, when he wanted to kindle his fire. When he used the coal untreated, the fire was going out, and doing all sorts of things

Mr. Stantral. In using this treated coal in the ordinary house furnace, does it require any modification of the furnace?

Mr. Williams. No, not the slightest. The coal will be sold all treated. You will use it just like any other coal. It is possible that as it produces a little longer flame, you may have to be more careful about the gas, and have more vent for the damper, but aside from that, it works beautifully, so far as holding the heat and responding quickly whenever you want to have a live fire, particularly in the early morning.

Doctor Carmichael. A dozen years ago there was peddled about the country a mixture of common salt and saltpeter.

Mr. Williams. Kem kom?

Doctor Carmichael. That was not the particular one.

Mr. Williams. Kem kom was sulphate of soda; sodium nitrate and common salt.

Doctor Carmichael. I know that in a large plant in the city the engineer tested the increased efficiency by the use of that. It was sprinkled on the coal, very much in the manner described. If I understand you right, these parties got hold of one corner of this truth.

Mr. Williams. As a matter of fact, there is nothing new under the sun. Even away back to 1802, these gentlemen I have quoted realized this thing was taking place, but not one of them could explain it. That is where the difference comes in. We think we understand it now, and can apply it in such a way that we will always get the result.

Doctor Carmichael. In connection with the discovery of the reason of this increased efficiency, as I understand it, although even before this was discovered, the art was really practised.

Mr. Williams. The art has been practised for 50 or 100 years.

Doctor Carmichael. Another question was in regard to the function which the sulphur might perform. You have there three pounds of sulphur or so.

Mr. Williams. No, that is not three pounds of sulphur, 0.15 of 1 per cent., you mean, in a ton of coal.

Doctor Carmichael. Do you not get a reaction by the sulphurous acid, the carbonate of soda, the caustic soda, and so on?

Mr. Williams. It hardly seems probable, because the only thing which seems capable of producing a reaction is the base. The base is the only thing which can stand in the fire, and you can't explain the continuity of this action unless you have something which stays in the fire, and which acts over and over again, and it is quite unlikely that the small quantity of sulphur would stay there, as you see. Sulphur in contact with red-hot carbon would be reduced, and go off as a gas.

Doctor Carmichael. Yes, but in the exhaust vapor, we know that common salt is decomposed, and you get sulphate of soda?

Mr. Williams. Yes, but it won't stay in contact with the carbon one moment. It goes up the chimney, and is gone in a moment.

Doctor Carmichael. If you are using chlorides, instead of nitrates, you would certainly have some decomposition; you would have some muriatic acid?

Mr. Williams. That is not important at all. I believe there is no decomposition whatever to your calcium chloride. I think the reaction takes place like this. The oxygen simply goes into the air. The other stays just the same.

Doctor Carmichael. That is hypothetical but you actually get the hydrochloric acid, when you try the experiment?

Mr. Williams. No, you don't get a particle of hydrochloric acid. That is a thing we have failed to prove the presence of. That is why the experiments were tried, to find whether it did go off. It does not go off, so far as I could find.

Mr. Underwood. Why did you exclude the moisture when you tried the experiment?

Mr. Williams. Simply because I had to try it in some way. I did not want to be bothered with the moisture present. I think another time I will try it with moisture. You can't try all experiments at once; you have to try either one thing or the other.

Mr. Underwood. Did you ever try the experiment of taking some litmus paper, and holding it over the coal?

Mr. Williams. That has been tried.

Mr. Underwood. When you were using it in a commercial way?

Mr. Williams. We have not tried it that way.

Doctor Gill. I still am somewhat skeptical. I am very much inclined to question whether oxygen will go into chloride of calcium under those circumstances. I am not very fresh in my physical chemistry, but there are physical chemists here. I would like to have their opinion of it. The next question I would like to ask is whether you tried the effect on the coal of dipping it in plain water, instead of chloride of calcium.

Mr. Williams. Yes, I have. When the coal is free from lime, it has no effect whatever. If the coal contains lime, you get the chemical action you speak of, and you get your coal to burn a little better than it will if it has not been dipped in water, but not so well as if you treated it with the definite amount.

Mr. Claflin. I would like to ask Mr. Williams if he has burned his coal in a draft that contained considerable moisture. I know in burning the ordinary buckwheat coal under our boilers, where we had a forced draft with a steam jet, and we replaced that by a fan, we found it did not work so well, although the fan draft is theoretically more economical. It was explained on the theory that we obtained carbonic oxide, water gas being formed there, and that the water in the draft seemed to be essential for the good combustion of the buckwheat coal. It seems that you might say, hypothetically, that the calcium chloride has the effect of the steam in the draft, and holds the moisture there a little bit longer. It seems to me the analysis of the ash would show, and that it would shed as much light on the subject as any analysis of the products of combustion. It would be very simple to find out in this treated coal how much calcium, how much chlorine there is in the ash; whether the chlorine is all there or not. I should think that the iron oxide in the ash would cause the decomposition of the calcium chloride, if nothing else, and would drive off the chlorine.

Mr. Williams. Well, in this experiment which was made in the tube, where all the gases pass through standard caustic soda, and the operation is conducted with a rapid stream of air for three hours, you had every chance of catching any hydrochloric acid which could go off by combination with the iron to form a chloride, or anything of that kind. There wasn't a trace of acidity of any kind, apparently. The experiments which have been conducted in the past three years have been conducted at all sorts of possible seasons, and the chances are that the amount of moisture in the draft varied very much on different occasions. As a matter of fact, we never failed to get the results. So far as any skepticism or doubt of the theory which I have suggested is concerned, it seems to me that it is incumbent upon anyone who finds fault with it, to explain the results that we get. We get the carbonic oxide. Now, how do we get it?

Mr. Bailey. In connection with that question Mr. Williams has asked, how they get the carbonic oxide, but how do they get it? In burning the Pennsylvania anthracite in a steam boiler, it is not at all uncommon to secure flames 30 or 40 feet long, showing carbonic oxide. It is feasible to secure flames of carbonic oxide 30 feet long. I think it could be secured by proper manipulation of Pocahontas coal.

Mr. Williams. The reason of raising flames 40 feet long is simply because the oxygen is insufficient for the combustion of the coal. I have stated that the flames which in the experiments we performed were 6 feet or more long—with treated Rhode Island coal, I think we could get 50, 60 or 100 feet long, if they wanted them. It is simply a question of having tubes for the flames, and not having air come in contact with the gas, so that combustion takes place. It is simply a question of distillation, conveying to a long distance, where you have moisture coming from the fuel, or possibly the draft, and also you have hydrocarbons

in your fuel which are decomposing. You will get carbonic oxide gas, because you could not expect anything else, so long as you have oxygen there. Those flames will be just as long as your tubes happen to be, so long as there is no oxygen there that will burn up the carbon. The objection which you suggest does not seem to be applicable.

Mr. Bailey. It was not an objection. It was whether or not such conditions had been taken into consideration when basing the theory on the treated and the untreated coal.

Mr. Williams. I think the length of flame is immaterial. All we know is that when our coal is treated we are able to burn it and obtain results in making the coal behave like a long-flaming coal. Never mind what the exact length of the flame is which we can obtain with the untreated coal. We simply note the result. I do not pretend to say that this theory has been studied to such a point that everything is known about it. I simply present it, as I understand it, up to the present time. I know I can get the results; I know carbonic oxide is produced. I know that with the untreated coal it is utterly impossible to raise steam quickly; it is utterly impossible to make that coal kindle rapidly, but with the treated coal, you can do so in just about a half or a quarter of the time, get all the heat you want, and all the evaporation you want.

The Chairman. What is the nature of the ash; is it a fluxible ash?

Mr. Williams. It depends upon where the coal comes from. I have found it to be quite variabie. In some places it contains considerable lime, but I have figured upon the blast-furnace moisture analysis, and it is not, so far as I have been able to find, from the analysis which I made from large quantities, of such nature that it is fluxing. That is to say, so long as your temperature is not excessive, you are not liable to flux that ash in such a way that it will trouble you. In domestic fires, the heat which is realized does not seem, with the quality of Rhode Island coal which we seem to be getting now, to flux it, and the ash which is produced is very light, and can be got rid of as the coal burns, entirely different from Pennsylvania coal. The Pennsylvania coal seems to kindle clear through, but the interspersed slate which is in the Pennsylvania coal centers and imprisons carbon, which is not reached by the oxygen, and the draft at all, and the lumps will go out, and will contain a large percentage of carbon. When you come to break the lumps open, you will find unconsumed carbon in the inside, which you can't burn under any conditions. You take the refuse from the ordinary house furnace. You may find 40, 50, 60 or 70 per cent. of unconsumed carbon in it, according to the care which has been used in running the fires. Of course, that is only 50 or 60 per cent. of the weight of the ash in the fuel, which does not mean that half of the fuel is unburned, but it means that one-half of the weight of the ash is unburned. With Rhode Island coal, on the other hand, the temperature does not seem to be sufficient to fuse the ash. There is no volatile matter to speak of in the interior of the lump. The ash is light, drops off; your fire is practically clean, so the lump burns completely. If you take one of those lumps and drop it in water, and take it out, it will look just about the same as when you put it on the fire, but the ashes drop off, and the coal is clean.

Mr. Barber. What are the B.t.u.?

Mr. Williams. That seems to be a contradictory result. With some grades of Rhode Island coal containing possibly 2 or 3 per cent. more ash than Pennsylvania coal, it will frequently, in domestic fires, give better results. In other words, the actual combustion of carbon, the actual utilizible heat units which you get from the combustion of the Rhode Island coal, seems to be greater than the Pennsylvania anthracite of higher caloric value.

Mr. Barber. What is the number of heat units and per cent. of ash?

Mr. Williams. That depends on the grade of coal. We have obtained 7, 8, 9, 10 per cent.; up to 18. It will go anywhere from 10,000 heat units up to 12,500 or 13,000. We have had all kinds. I do not pretend to know what the coal is which we are going to mine, because it is still underground.

Mr. Barber. How it is for steam boilers with a forced draft?

Mr. Williams. If you have a shaking grate, there is no difficulty. We are not intending to use it for steam boilers; we are intending to use it for domestic use.

Mr. Barber. Is there a larger percentage of ash in the Rhode Island coal than in anthracite?

Mr. Williams. Some of the Rhode Island coal shows very little, only a small per cent.; others contain 5 or 6 per cent. These samples which I have here are not at all fit samples. They are only abandoned samples which I have. They are not supposed to be representative samples at all of the kind of coal which we are getting now. These may run high in ash. I know one of them is about 15 or 16 per cent. The other is lower than that, about 9 or 10 per cent.

Mr. Barber. When you get the coal out by the diamond drill, is it possible to tell at what angle the drill passed through?

Mr. Williams. Not very well, because the drill twists, and you can't get your direction. Here is a core which gives the angle of dip. You can measure from that. There is one other hole which was put down, hole No. 9; that would be the seventh hole which we put down. There we went through 7½ feet of coal; 4¾ feet of that coal, of this size, was saved and sent to my office. I made two analyses of it, so as to get all the information I could from it. Part of it was high in ash, and the rest was below 11 per cent.

Mr. Little. I would like to ask Mr. Whitney whether he regards the analysis of the five-pound sample of Rhode Island coal which appeared in the Boston *News Bureau* of January 24 as in any way representative of the quality of the coal.

Mr. Whitney. I do. That was taken from the lower level, brought up in a large lump, and I broke off a piece and sent it to Mr. Williams. It was taken from the north shaft, one of the lower levels. I think it is fairly representative of the coal on that level, so far as I am aware.

The Chairman. This would seem to be an easy matter to demonstrate. Has anyone with sufficient intelligence tried the experiment and failed? It would seem to be a matter that could be done at once, if at all. Do you find anyone who has tried the experiment and failed to get the ignition which you describe?

Mr. Williams. I am sure I do not know. I know that down at the island of Rhode Island, they have been using this treated coal, which was treated with this proportion. I think the solution they used was about 5 per cent. calcium chloride. They have used it all winter in a range where they cook for twenty-five or thirty men, and it answers the purposes of the kitchen perfectly. They do not seem to have any trouble at all. There is that station master I have already spoken of at the station at Portsmouth, who has used it in the station there, and gets perfectly good result with it. We treat that coal, simply hand it over to him. It is practically air dried. He simply uses it as he would any coal.

The Chairman. Your statements have not been contradicted?

Mr. Williams. Not that I know of. There have been some exceptions sometimes by people who thought we put something extraordinary in the coal; that we have loaded it up with chemicals to get this extraordinary result. As a matter of fact, we have not been making any demonstration of any kind. We have simply been attending to our own business, and trying to develop this coal, get it out of the mine, and incidentally to get all the information we could for ourselves. We have not been making any demonstration for the public. It is simply the public which has "butted in," now and then, with a lot of skepticism and all that, and insisted upon calling us fakes and everything else, and trying to prove that we didn't know what we were talking about. As a matter of fact, we think we know pretty well what we are about.

Mr. Stantral. What relation do the deposits in Cranston have to these deposits?

Mr. Williams. This coal occurs over the whole of the Narragansett basin. It has been described by Professor Shaler, of Harvard, years ago, in a monograph which he published, and which is available to everybody. The coal exists over the whole of the Narragansett basin, fifty miles long by twenty in width. The center of it seems to be about where we are, on the island of Rhode Island. Cranston is on the edge of the field, and according to Professor Shaler's report, the coal has been most disturbed, geologically, on the edges of the field. The coal is very much more graphitic at Cranston. The same condition exists at Mansfield, which is further north, and there, where there is some excellent coal in small quantities in spots—perhaps even better than we get—the continuity of the coal does not seem to be established. It is so much distorted and twisted that the beds are not continuous. It is not to be depended on, so far as we know. The graphitic condition exists in its most marked condition near the top of the seam, where the sliding has taken place. Below, the coal has less graphite.

Mr. Barber. On the treated coal, did you notice these flames of some inches, or feet, in length?

Mr. Williams. The treated coal invariably gives these long flames.

Mr. Barber. The treated anthracite does?

Mr. Williams. Any anthracite coal will give it. The process can be applicable to any anthracite, but it is more difficult to judge whether the flames are due to the matter which is present in the matter in ordinary anthracite, or to the treatment. That is why the treatment, when applied to Rhode Island coal, is very much more satisfactory, because as there is, apparently, so little combustible volatile matter, you know whether the chemical is entitled to be credited with the flame.

Mr. Barber. Did you get flames in that first test of buckwheat coal, or didn't you?

Mr. Williams. We got flames, but they did not begin to be as long as they were in the coal which we had treated.

Mr. Barber. In orther words, your increase in efficiency is indicated by an increase in the length of flame?

Mr. Williams. No, not only by an increase in the length of the flame, but by the fact that we were able to burn more coal in the same time on a given extent of surface, under the same conditions of furnace. I suppose the draft would have to accommodate itself to the requirements. The same pressure of steam was maintained in both tests.

Mr. Barber. Throughout all periods of the tests?

Mr. Williams. Yes. The boiler tests were made by Professor Miller, of the Institute of Technology, and it was his lookout to see that the steam-engineering part of it was done properly.

Mr. Barber. Provided there was a variation in the forced draft at different times, there might have been some different furnace condition that might have varied your efficiency, and was not entirely due to your treatment?

Mr. Williams. Well, of course, where you are burning more coal per square foot of grate, you have got to have more draft to do it. There is no getting away from that, but all the other conditions were just as much the same as it was possible to make them. The only point that is interesting is that taking the two fuels, trying to burn the untreated coal in one case, just as efficiently and just as fast as it was possible to burn it, they only got a certain result, whereas, trying to burn the treated coal, which is of a poorer quality, under just as nearly the same conditions as it was practicable to realize, we got a very much greater efficiency.

Mr. Barber. Could a layman, we will say, using your process, who could not see the flames, or who could not notice any difference in the efficiency between the treated coal and the untreated coal naturally lay his failure to the nonappearance of flames?

Mr. Williams. No, I don't think so. The proof of the pudding is in the eating. The person who uses treated Rhode Island coal for domestic purposes is simply interested in having a fuel which is going to light in his fire, and not go out when his back is turned. That is the way Rhode Island coal, which is not treated, behaves. You treat it, and it behaves itself, and it will give you the practical results you want. You don't care whether there are flames or not. The only question is whether it will burn or not.

Mr. Barber. This question of the increase of the efficiency over anthracite is a side issue?

Mr. Williams. The increased efficiency of the treated coal is simply an incident of the fact that the coal was of a poorer quality and gave better results after it was treated.

Mr. Barber. For instance, anthracite coal of the same grade, showing the same results, treated and untreated, would the treated coal give an increase in efficiency?

Mr. Williams. Well, the quantity of water you could evaporate would be just the same, because it takes just so many heat units in both cases. The treatment does not add one unit to the efficiency of the fuel. It makes it possible to burn the fuel in one case, where in the other it will not burn.

Mr. Barber. I do not think we are agreed on the meaning of efficiency. I do not mean the efficiency as occurring in the coal. I mean the efficiency as realized. Will this process increase the efficiency of anthracite coal?

Mr. Williams. It would in this way, that the temperature being greater, you can burn your coal a little more completely in one case than you could in the other, so you would probably have less refuse with the treated coal. You could burn your treated coal at a more rapid rate, if you wanted to.

Mr. Barber. What increase in efficiency would you expect?

Mr. Williams. That would be guesswork. I do not know.

Mr. Stantral. You have to soak the coal in the solution; a mere baptism by sprinkling won't do?

Mr. Williams. You have to immerse it, but it does not have to stay in the solution more than a quarter of a minute. It is just a question of getting the solution over every part. You can leave it in two hours if you want to, but it is not necessary. It is simply a question of having the salt soak in a little way.

Mr. Stantral. What will be the effect of leaving this coal out of doors, letting it get rained on? Wouldn't the chloride of calcium get washed off?

Mr. Williams. We had a lot of information on that point. We had some coal which was exposed to winter weather for fourteen months. Then it was burned, and we obtained the same results at the end of that time. As a matter of fact, my observation, in regard to piles of coal out of doors seems to be that where the coal is stacked up in the yard in very great thickness, the rains will not penetrate more than a few feet into the coal, so that the washing action is very slight indeed. I should say that the only way in which you could wash out calcium chloride (which seems to stick like grim death to coal) would be to turn a river on it, and have it run for hours. Ordinary rains will not do it. The freezing in winter weather protects the coal, so that the interior is not affected. Then the fact that the substance brings out a catalytic action would make up for the slight washing on the surface, so I do not think there would be any appreciable effect.

Mr. Whitney. I want to say that if any of the gentlemen are interested in the practical solution of this question, if they will step into Mr. Watson's office, 68 Devonshire street, I have no doubt he would be very glad to show the coal to you burning. I have nothing to do with it myself. I did not know he had the coal there, but I found he had some there, and went in to see it. I went in at half past one. He said he had started the fire at half past six, and it was burning then.

At the close of the discussion a vote of thanks was extended to the speakers of the evening for their interesting and instructive papers.

Different Designs of Expansion Joint

Descriptions of Several Standard Types. Showing the Purposes for Which They Are Best Adapted, Their Construction and How and Where Used

BY WARREN O. ROGERS

A necessary factor to be taken into consideration in steam-plant design is that of expansion and contraction of the steam pipe. If no provision were made, the pipes would buckle and cause more or less trouble at the joints throughout the entire steam line. To obviate this, various types of expansion joint have been designed, some of which are illustrated and described herewith.

What is known as a standard transverse unbalanced expansion joint is

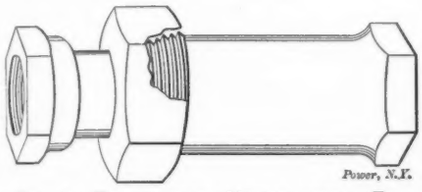


FIG. 1. TRANSVERSE UNBALANCED EXPANSION JOINT

shown in Fig. 1. It is very simple in construction, consisting of a brass cylinder, in which a brass sleeve is fitted and made tight by means of suitable packing, similar to the method used in packing a steam-valve stem, the packing being forced tight around the sleeve by the stuffing-box nut. The pipe line is connected to either end by a threaded joint. A slightly different design is shown in Fig. 2. The stuffing box is fitted with a gland and gland bolts for taking care of the packing adjustment. These two designs are manufactured by the William Powell Company. Similar designs to

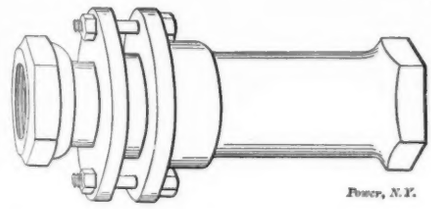


FIG. 2. DIFFERENT DESIGN OF STUFFING BOX

Figs. 1 and 2 are made by the National Tube Company, the difference from Fig. 2 being that three- and four-gland bolts are provided instead of two, in the iron-body type.

A type of joint made by the Wessinger Company is shown in Fig. 3. It is made extra heavy, and has a bearing box to guide the expansion sleeve, thus relieving strains and frictions from the moving parts of the joint. The sole plate serves as a foundation to fasten the joints in place. The joint is made tight by the packing method, the features of the stuffing box being shown in the illustration. The joint operates similarly to those shown in Figs. 1 and 2.

Another type of expansion joint, shown in Fig. 4, is of the packed type. It is made with both single and double brass slips, and in addition to the customary form of packing used with this type of joint, is equipped with a water seal along the slip. The body of the fitting is anchored by means of anchorage lugs.

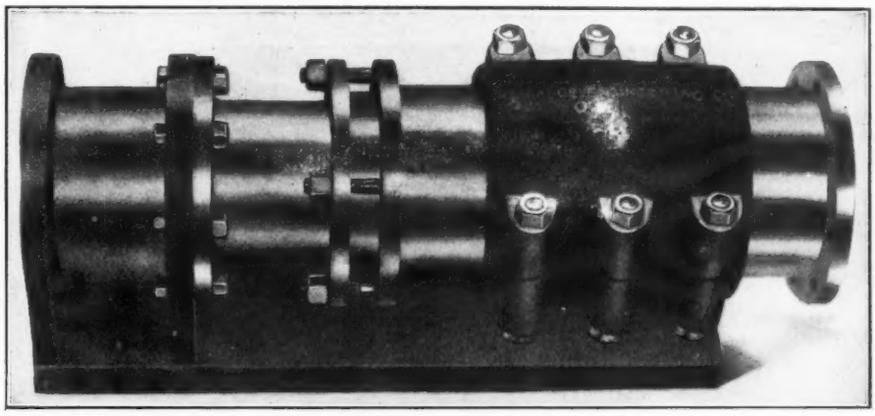


FIG. 3. WESSINGER EXPANSION JOINT WITH FLANGE CONNECTIONS

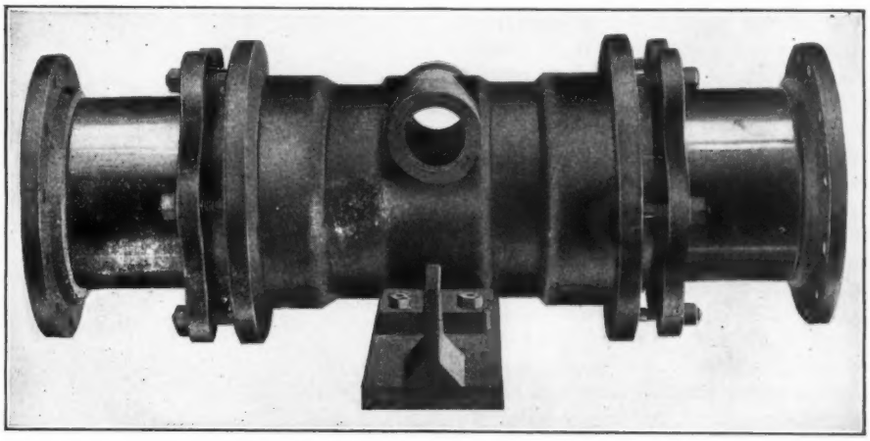


FIG. 4. DOUBLE EXPANSION JOINT WITH WATER SEAL

At the top of the anchorage pieces is an opening for the purpose of taking out dry steam from the line. As this service is taken from an anchored point, it is apparent that the service line will not leak at the point of connection. With the anchor plan of expansion joint, the line is always in a state of equilibrium, and can respond at once to the slightest difference in temperature without straining any section of the line.

Another type of expansion joint is shown in Fig. 5. It is of the tunnel type, having double expansion, one on each side of the anchored body.

In Fig. 6 is shown one of the single-type joints, having but one side of the anchor connected with the pipe line. These joints are manufactured by the American District Steam Company, and are used in its system of underground steam distribution.

An exterior view of a balanced expantion joint for steam use is shown in Fig. 7. It is manufactured by H. B. Underwood & Co., and is known as Smith's expansion joint. As the pressure varies in the steam pipe, the expansion and contraction taking place in the pipe line are taken care of by one end of the expansion joint slipping through the other section, which is made steam-tight by packing. As the inner area of the slipping section is equal to the area of the pipe and forces in the opposite direction to the pressure exerted in the steam pipe, a balance is secured, which relieves the stress brought to bear on the joints, the

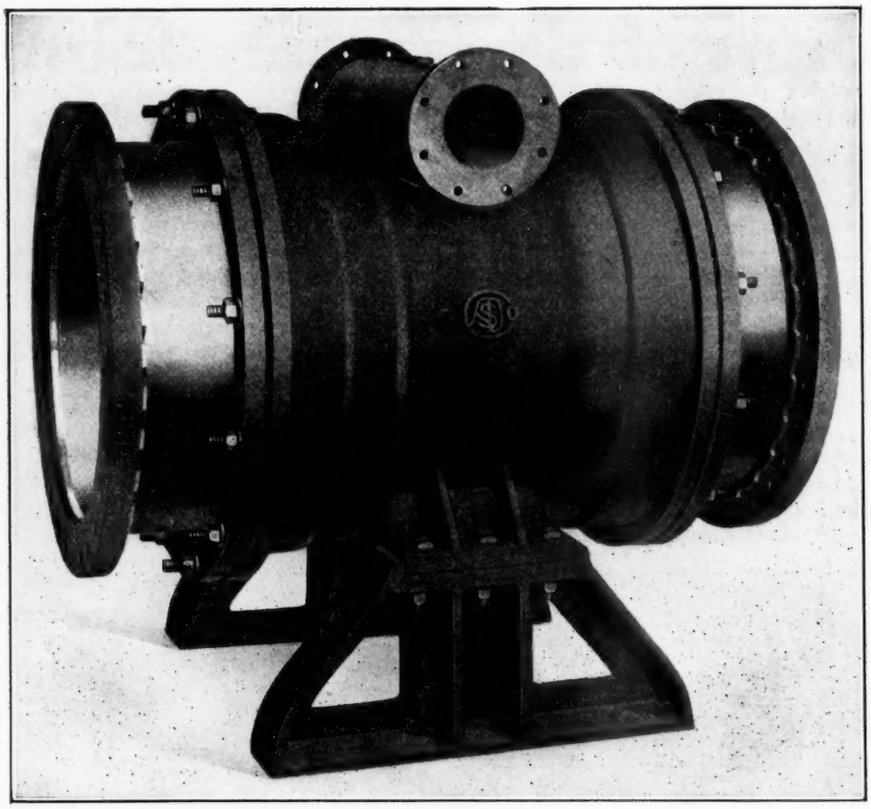


FIG. 5. TUNNEL TYPE DOUBLE EXPANSION JOINT

only friction being that due to the packing in the stuffing box. It is designed for any kind of metallic or fibrous packing. The joint as shown in Fig. 8, a semi-sectional view, gives an idea of the general construction.

A somewhat novel design of expansion joint is shown in Fig. 9. It is known as the Hyflexmet, is the product of the American Metal Hose Company, and is applied in the following manner:

At some suitable point in the pipe line the two ends of the pipe are connected by suitable lengths of strong, flexible metallic hose, forming a pressure-tight union with each pipe. The construction of this hose is shown in Fig. 10. The joints are made of steel or copper ribbons spirally wound with interlocking edges. Under the lip of each section asbestos packing is placed to insure tightness, and the metal is reinforced by single or double sheathing of woven flat-pressed steel wire which is conformed to the surface.

This piece of metallic hose is secured at each end to the flange connectors which are bolted to the flange on each pipe end. They are suitably packed and are secured by through bolts, which also set out the packing rings and form a proper holding medium between the connector casting on the steel-hose sheathing by means of an internal taper in the casting which grips the sheathing.

This type of expansion joint is provided with a safety provision for limiting the distortion of the end stresses to which it might be exposed. This is in the form of two rods which are placed on either side, passing through and connecting with a pipe clamp secured to the hose leg at mid-length. This feature is illustrated in Fig. 9.

The Crane Company manufactures several types of expansion joint, among which are the following: In Fig. 11 is shown a design of unbalanced slip joint. Such a joint is for use where the expansion in the steam line is so great that it is impossible to use a bend or other design of connection in which the operation depends upon the elasticity of the metal. It is made with either brass or iron sleeves, with cast-iron bodies, and is fitted with safety tie rods, as shown. It is also made either for flange or threaded connection to the steam line. It is necessary to provide a strong anchor at a suitable point on the pipe line so that as the pipe lengthens the end will be forced into the joint. This is because every pipe line which is fitted with unbalanced expansion joints has a tendency to pull apart. In a joint of this kind it is necessary to use anchors of sufficient strength to resist the friction caused by the packing in the stuffing boxes, hangers and supports.

A balanced expansion slip joint is shown in Fig. 12. Such a joint is adapted for conditions where the expansion of a steam line is so great that the ordinary bend will not take care of it without excessive strain. It is designed similarly to the unbalanced kind, but being balanced it is only necessary to anchor the end of the pipe line. The packing is either asbestos or a good metallic packing, if the

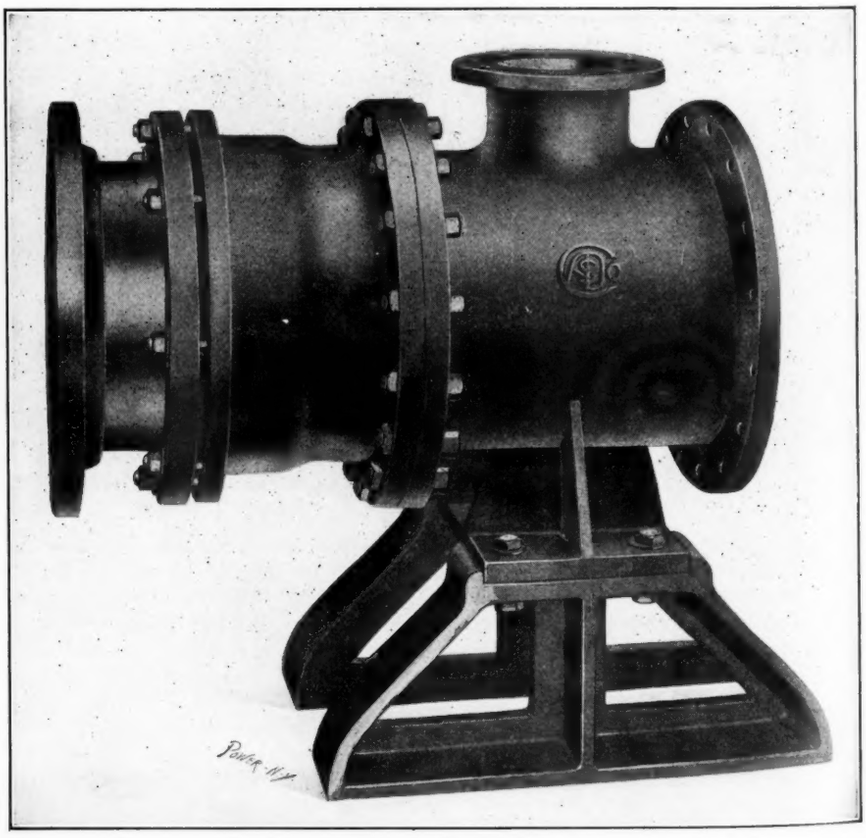


FIG. 6. SINGLE EXPANSION JOINT

steam is not superheated. Besides having the regular cylinder and sleeve, two balancing cylinders are placed on each side. They have practically the same area as the main sleeve. It will be seen that as the steam tends to force the pipe and joint apart its force is counterbalanced by steam at the same pressure in the two smaller cylinders, which force the joints in the opposite direction, forming a sensitive balanced joint.

joint is especially adapted for use in pipe lines with a working pressure up to 250 pounds per square inch. Fig. 14 shows the application of such a joint to a pipe line.

The type of expansion joint made by the Lunkenheimer Company is shown in Fig. 15 and is designed on lines similar to those shown in Figs. 1 and 2. It consists of one brass-tube sleeve fitting into another, the inner tube being smooth at

take the place of the elbow and nipple, the expansion joint forming the substitute. One section of the joint fits into the other as shown, the joint being packed with suitable packing, held in place by the stuffing-box gland.

The joint is prevented from pulling apart by the large bolt which passes through the center of each tee section, and is held by nuts. The nuts are in turn capped, and the exterior of the joint

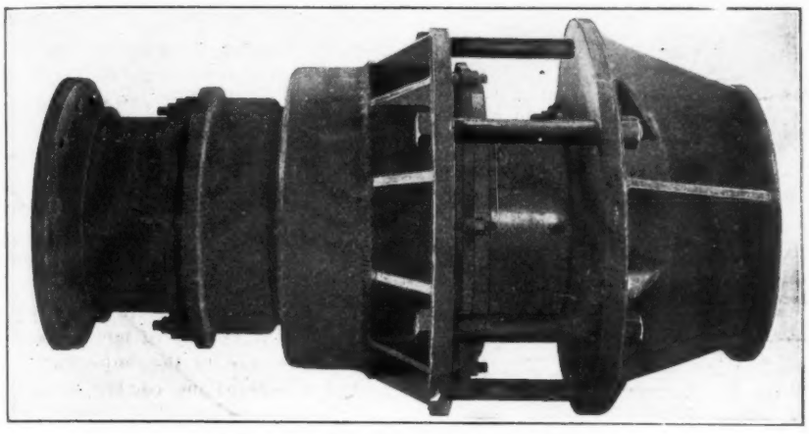


FIG. 7. BALANCED EXPANSION JOINT

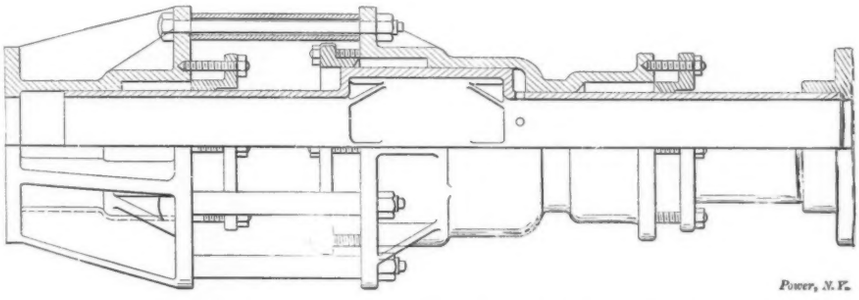


FIG. 8. SEMISECTIONAL VIEW OF THE SMITH JOINT

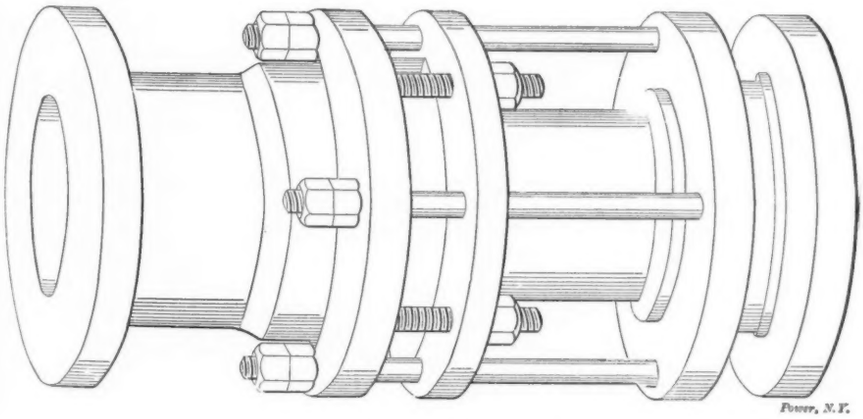


FIG. 11. UNBALANCED SLIP JOINT

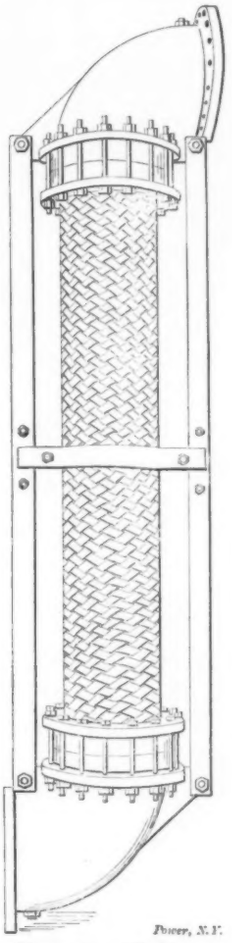


FIG. 9. "HYFLEXMET" EXPANSION JOINT

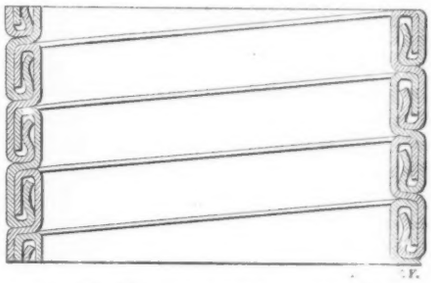


FIG. 10. CONSTRUCTION OF THE PIPE

The Crane extra-heavy expansion joint is shown in section in Fig. 13. It is arranged with a brass slip ring on the sleeve, also a ring of metallic packing which fits with a ground joint against the brass surface on the stuffing-box gland. This makes a tight joint, and at the same time provides a bearing on which the joint may swing. This type of

one end and the other threaded and screwed into a sleeve connection. The outer tube is threaded on the inside at one end and on the outside at the other, on which is screwed a stuffing-box nut, in which packing material is placed to prevent leakage.

In Fig. 16 is shown the design of an 18-inch expansion joint. It is designed to

has the appearance shown in the upper drawing in Fig. 16.

Another type is shown in Fig. 17, and is designed to be placed in a vertical pipe line. It is bolted in place in the same manner in which any flange joint is made. The lower end is drilled and capped for a drip pipe to carry away condensation.

Fig. 18 shows the construction of a

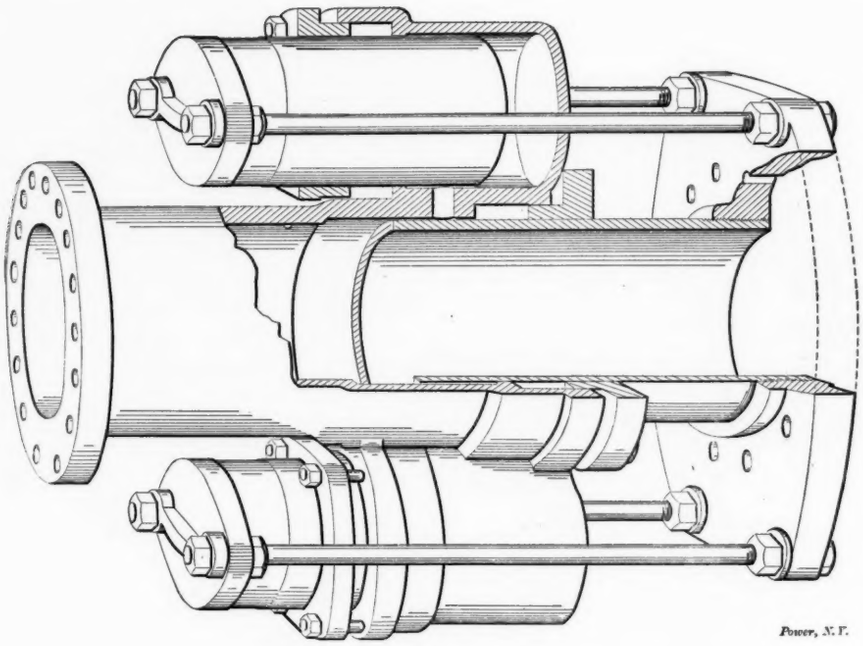


FIG. 12. BALANCED SLIP JOINT

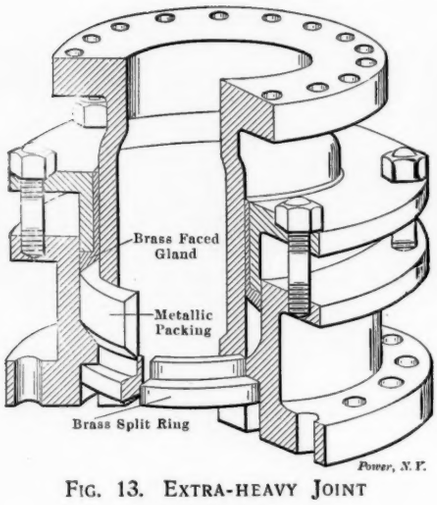


FIG. 13. EXTRA-HEAVY JOINT

balanced expansion joint made by the same company as those shown in Figs. 16 and 17, the Best Manufacturing Company. The section *A* represents the slip portion of the body, *B* the body proper, and the solid end of the slip portion is shown at *C*. On account of the solid end *C*, there is no resistance offered by the part *A* against *B*, therefore the joint will not blow apart. Owing to its balanced features the pipe line requires anchorage only sufficient for the expansion.

The Wainwright improved expansion joint, manufactured by the Alberger Condenser Company, is illustrated in Fig. 19. It is no larger than the diameter of the flanges of the pipe in which it is inserted and is made from a seamless copper cylinder having its end flanged over on the cast-iron flanges, and is so made that it can be readily covered with a nonconducting material to prevent radiation of heat.

It is made for both high and low pressures. The high-pressure type consists of a main corrugated cylinder of soft copper and an inner cylindrical slip tube of hard copper or composition, internal and external equalizing rings of cast iron and connecting flanges of cast iron or steel. The function of the corrugated tube is to provide for the movement due to expansion or contraction in the pipe line. The equalizing rings are used to limit the amount of movement in each corrugation and to cause each convolution to assume its part of the travel. The improved type is made for working pressures up to 200 pounds, according to the size of the fittings.

The low-pressure type of expansion joint shown in Fig. 20 has been found of use in exhaust-steam lines, either to the atmosphere or to the condensing apparatus. It can be used as a connection between a steam turbine and condenser, not only protecting the turbine from the strains due to change of temperature, but from those due to the imperfectly supported weight of the condenser and pip-

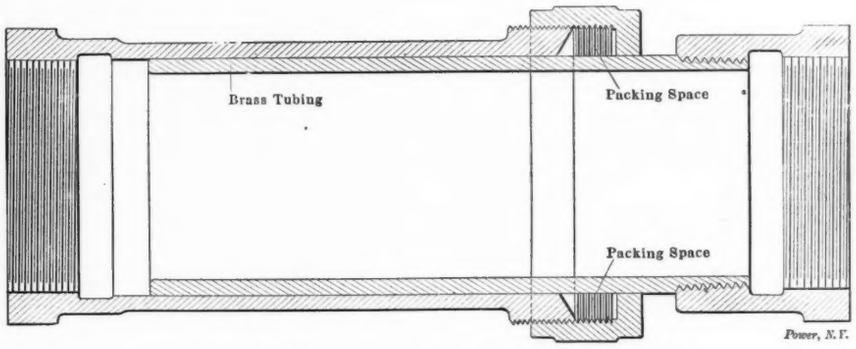


FIG. 15. LUNKENHEIMER EXPANSION SLIP JOINT

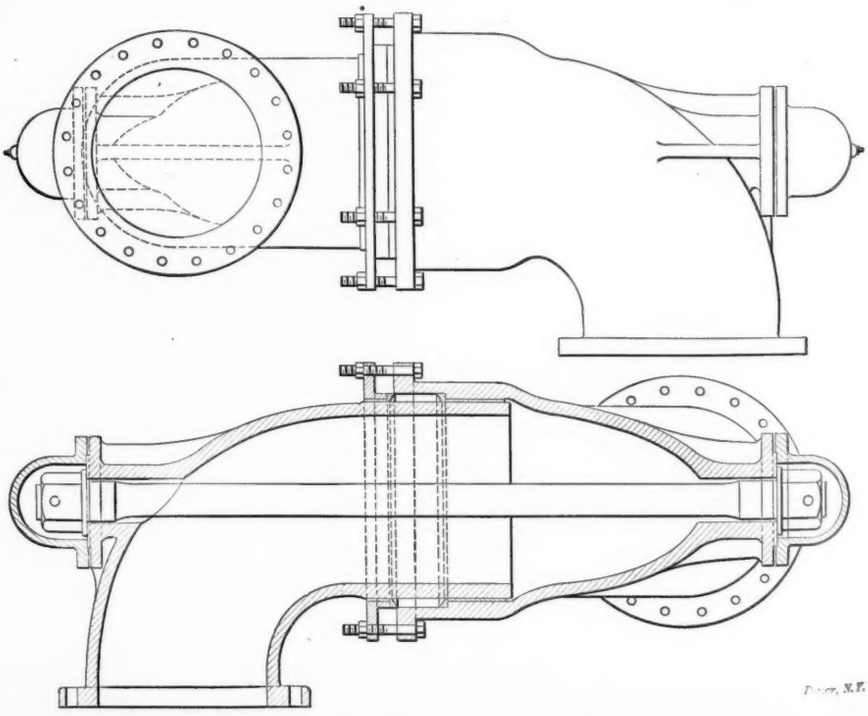


FIG. 16. AN 18-INCH NIPPLE AND ELBOW EXPANSION JOINT

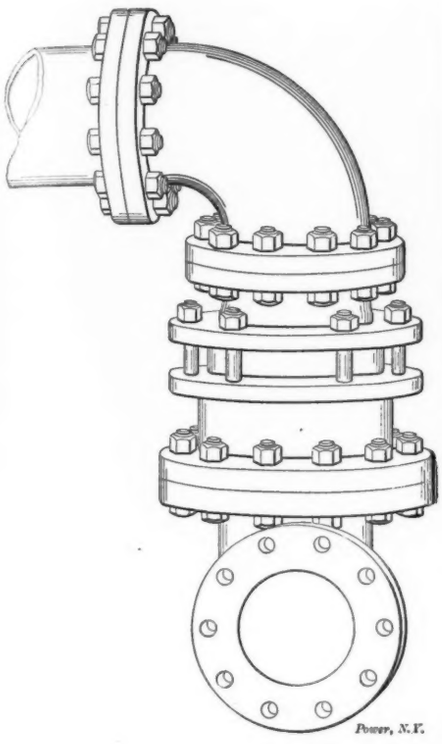


FIG. 14. APPLICATION OF SWING JOINT

ing. It is frequently used as the only connection between the turbine and condenser, and its importance can be appreciated when it is considered that the former machine contains steam of very high pressure and the latter steam of the lowest temperature and pressure obtainable. It is also suitable for connecting the various cylinders of compound or triple-expansion engines, in order to relieve them from strains which may occur between the connected parts.

The type of expansion joints shown in Fig. 21 is made by the Central Station Steam Company. Two semi-sectional views are shown of the joints, one showing the joint open with the pipe contracted, the other closed with the pipe expanded.

It is made with two diaphragms in each joint, shown at *A*. When the pipe to which the joint has been attached begins to expand, the diaphragm, which is the weaker, works first. This diaphragm bends until the backing rings *B*, which support it, engage the stop rings *C*, and compel them to move bodily on to bend the other diaphragm. A double expansion joint is also made, somewhat along the line of that shown in Fig. 4.

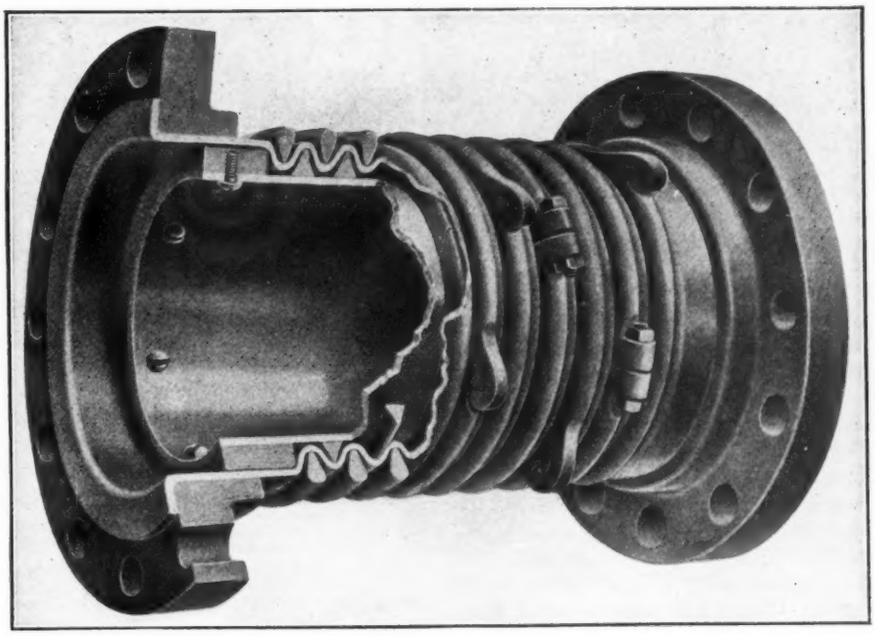


FIG. 19. WAINWRIGHT IMPROVED EXPANSION JOINT

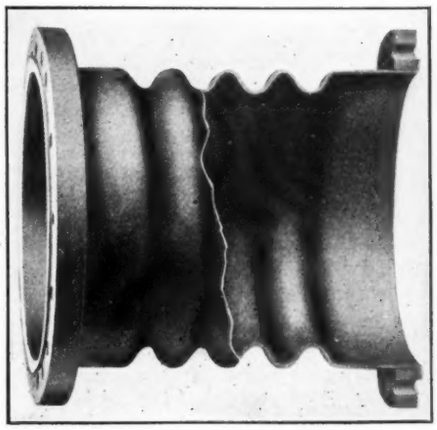


FIG. 20. TURBINE EXPANSION JOINT

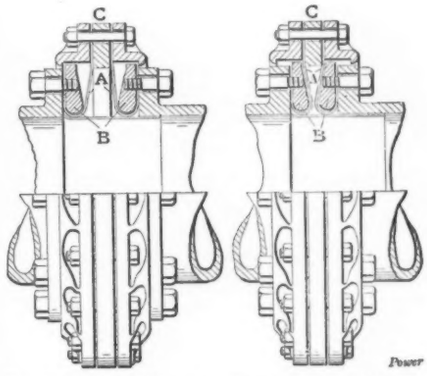


FIG. 21. NEW TYPE OF EXPANSION JOINT—OPEN AND CLOSED

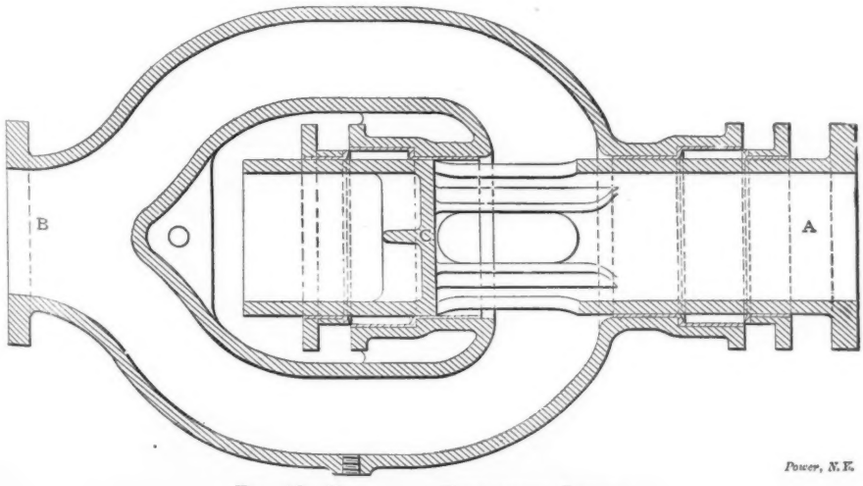


FIG. 18. BALANCED EXPANSION JOINT

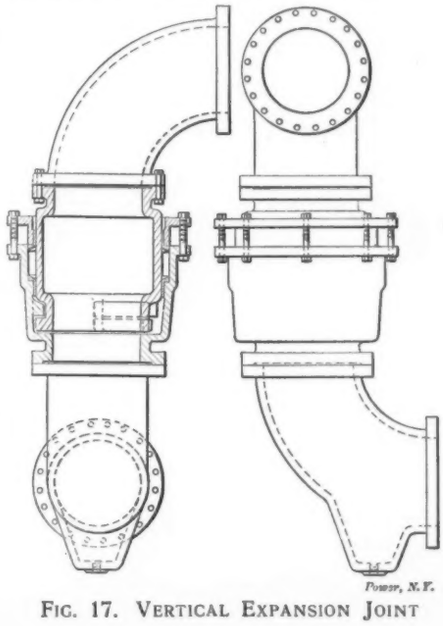


FIG. 17. VERTICAL EXPANSION JOINT

POWER AND THE ENGINEER
DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the
Hill Publishing Company
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505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

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Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

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Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1909 *we printed and circulated* 1,875,000 *copies of* POWER.

Our circulation for January, 1910, *was* 154,000.

February 1	36,000
February 8	35,000
February 15	35,000
February 22	35,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

What Is the Matter with the Cooling Tower?

The discussion on cooling towers at the annual meeting of the American Society of Mechanical Engineers and the brief abstract of the paper in our issue of January 18 give rise to some pertinent afterthoughts. No observing person (characterized by the "insiders" as a meddler) will deny that the general attitude of the average power user is decidedly apathetic, but that on the other hand the demand is really active from both steam- and gas-power plants. Why, then, is the cooling tower held in such low estate and not as a recognized adjunct to an efficient power property? Only three reasons seem to have been advanced.

First: That it has not been required under the favorable conditions of American power development.

Second: That the design has not been perfected to such a point as to evolve an efficient structure at moderate cost.

Third: That a condition has arisen resembling a "corner" on brains by a comparatively few builders who practically control the market.

The American engineer of today cannot lightly be dubbed passé. On the other hand, he is always open to correction and lets nothing useful slide through his fingers. Has some sudden revolution in power equipment come about to create such an active demand for cooling towers as there exists at present? Is the engineer asleep or the manufacturer?

We submit that there is something radically wrong with the state of the art when a tower equipment built of the cheapest materials with the most inexpensive labor, costs more than the condensing equipment built of expensive materials and requiring much machine work of a high order. One defender of the "corner" proudly asserts this inalineable right of the few to know the subject profoundly, and to profit by it handsomely. All this is impressive but not progressive. The time has passed when the purchaser of power apparatus and equipment, even the layman, is satisfied to remain in profound ignorance of the character of his purchase, basing his actions on someone's say-so, much less the constructing engineer. Why this ban of secrecy on such a simple contrivance? With other types of apparatus such as turbines, boilers and condensers the manufacturers' attitude is becoming much that of an open book. What tomes of experience might be written by the turbine salesman in his efforts to convince a lay purchaser of the superior technical features of his product? Should not at least the same degree of coöperation be exerted in cooling-tower practice?

What is urgently needed is a campaign of education in both directions. Let us take the purchaser into our confidence as in these kindred lines, instead of forcing him to experiment and build for himself in untried fields simply as a relief from difficulties real or fancied and high investment cost, real indeed. With an active market the cost will greatly reduce to reasonable commercial limits. Pending this readjustment it is certain that the present application of "cut and try" method with its disastrous failures and mediocre successes will continue; whereas the cooling tower should take its rightful place in the schedule of power equipment of a large proportion of power properties, both steam and gas.

Of the many designs there is a wide range of choice adequate for the various normal conditions of plant operation. It is true that Europeans have developed their cooling-tower work to a much more impressive and possibly more efficient stage than Americans, yet the list of American plants shows some conspicuous successes and many failures also. Strange as it may seem, the average purchaser is able to exercise but meager powers of discrimination between the good and the bad, possibly choosing in his extremity a product little better than the proverbial brush-heap, which latter has the distinct advantage of giving fair results without excessive expenditure.

There seems to be an honest difference of opinion regarding the possibilities of a natural-draft tower with auxiliary-draft apparatus for peak loads and bad weather as compared with a straight forced-draft type. Europeans have highly developed the chimney type or natural-draft tower. American practice runs to free draft very largely. The overload or combination type seems to have been dodged by common consent. This does not seem quite justifiable. Could not a design be worked out effectively? We believe a much wider application and usage would result and a much lower cost of equipment per unit capacity of plant. The design suggested in the American Society of Mechanical Engineer's paper may not be as impracticable as it seems at first sight. With a comparatively open

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filling (less than 40 per cent.) the increment of resistance due to the addition of fan draft seems hardly so great as to occasion a reversal of flow at the entrance. Undoubtedly it would be difficult to preserve uniform air distribution for the lower zones of the filling, but this would not be serious for peak-load work. It should be remembered that in natural-draft towers a comparatively low velocity is the rule. The additions of some auxiliary draft might therefore come well within the limits imposed by the resistance of the filling without eliminating the natural-draft effect.

This, at any rate, is a line of development well worth further study. It bears a strong resemblance to the overload valve on a steam turbine, both having for their object the reduction of the cost and bulk of the tower while maintaining considerable excess capacity on overloads.

Furthermore, the subject needs a new mode of expression to facilitate more accurate technical analysis of performance, efficiency and rating. The author of the paper mentioned has used a unit of expressing rate of heat dissipation in B.t.u. per square foot of wetted cooling surface per hour. This unit may further be modified to take account of rate of air and water movement. For atmospheric type or open tower the unit obviously will not apply unless the aggregate superficies of the falling drop be reckoned as has been proposed. (Just how the surface of spray and vapor should be reckoned, we have not been enlightened).

Fortunately, the improvements in condensers are forcing this issue. A makeshift cooling equipment will not be tolerated with a highly efficient condenser, and *vice versa*. Incidentally, the gas-power plant will benefit from the development. Let the educative campaign proceed in spite of the unbelievers.

Careful tests of the effect of superheat on the economy of the four-cylinder triple-expansion marine engine, 11½x19x22 11/16 x22 11/16 x18-inch stroke, on board W. D. Hoxie's 200-ton yacht "Idalia" show the heat consumption with 105 degrees of superheat to be 89.4 per cent. of that when using saturated steam. In other words, a saving of 10 per cent. by using 100 degrees superheat, or roughly, 1 per cent. saving in coal for each 10 degrees of superheat, a result which agrees with the approximations given in good handbooks for estimating a gain of this kind.

The tests are of further interest as the only lubrication that was used in the main and auxiliary steam cylinders was fine graphite mixed with water. A careful examination of the cylinders after being subject to this treatment for some time, showed the surfaces in good condition.

Perpetual Motion

Johnson City, Tenn., has gone perpetual-motion mad. Alfred T. Markwood is the "wizard" this time, and he is quoted as describing his production as follows:

"The machine is built in a table or platform three and one-half feet high, six and one-half feet wide and eight feet long. Fifty eighteen and one-half pound balls of tool steel, five and one-half inches in diameter, are used as the propelling force. The energy created by their operation by means of leverage is five times the resistance offered by the operation of the machine, including the friction and atmospheric resistance. The first model propelled a flywheel weighing eighty-six pounds at a rate of one hundred and fifty revolutions a minute and kept up this rate for two hours, when it was stopped. The second model had one-third more capacity than the first and operated successfully. The present ma chine when completed will be four times the capacity of the second and will develop two horsepower or more. The lift of the balls in the elevator has been minimized, and the impact has been eliminated by springs, and I believe that the operation cannot be other than successful."

Everybody in town is talking about it, and all the school boys are trying their hands. There are several advertisements in the For Sale column of the local paper for small blocks of shares of the Markwood Power Development Company, evidently by holders who are getting shaky.

It is just as impossible to create energy as it is to create matter. Energy may be transformed from one form to another, as matter can be, but when the process is all over the sum total, either of energy or of matter in the universe, will remain the same. It is perfectly safe to say that Mr. Markwood has not produced a machine which will deliver energy, unless it is receiving energy at the other end or has energy stored in it, which has previously been obtained from another source, and which once exhausted will have to be replenished, and that his machine cannot continuously give out more energy than is put into it. If he has produced anything to which this dictum does not apply, he has upset the entire principle of the conservation of energy, knocked the science of heat physics galley-west, and will be a bigger man than Bacon, Newton or Julius Cæsar, but until he has furnished the demonstration, compatible in its conclusiveness with the preposterousness of his claim, he will be regarded rather in the class with Keeley and Carroll. In the meantime a lot of ordinarily sensible and conservative people will give up good money for the stock.

It seems that there were mockers at Rhode Island coal even in the early part of the last century when William Cullen Bryant wrote of it:

> Yea, they did wrong thee foully—they who mocked
> Thy honest face, and said thou wouldst not burn.
> . . . . . .
> Thou shalt be coals of fire to all who hate thee,
> And warm the shins of all who underrate thee.

Boiler explosions have been so numerous of late that it need cause no surprise when it is announced that two more serious explosions have just occurred. On the morning of February 10, a defective sawmill boiler exploded at Crump, Mich., resulting in a fatality of seven and seriously injuring six or seven more. Complete details of the disaster will appear in the issue of March 1. The second explosion occurred on February 11 in the plant of the Congress hotel, Chicago. Two men were injured and one perhaps fatally. Further particulars will be published shortly.

It is reported that the British admiralty nas decided to substitute oil fuel for coal in the navy and use no other fuel. An initial order has been placed for eleven million gallons. Storage tanks have been recently completed in the neighborhood of Plymouth to hold 110 million gallons, and it is intended to fill these immense reservoirs from American and European sources. In the American navy the latest specifications call for water-tube boilers, fitted for the use of both oil fuel and coal; the oil fuel is to be used in conjunction with coal or independently.

Bursting flues in the boiler room of the Flint Electric Company, in Flint, Mich., on two different occasions within a week, recently, killed two men and badly scalded five others. The boiler had been inspected and cleaned only a few days previous on each occasion and had been under steam a short time when the accident occurred.

The number of deaths annually in Switzerland due to electric shock, says *The Engineer*, of London, has been almost stationary during the past five years, the figures being respectively 36, 30, 35, 35 and 36. Of the 36 victims of last year, 28 were engaged in electrical callings, and five were building mechanics killed while working by coming in contact with live conductors, principally on the roofs of buildings. Of the remaining three victims, one was a servant, another a factory hand, and the third a child. An analysis made of the accidents showed that the greater number was due to lack of precaution on the part of the victims, particularly in the cases of the electrical employees.

NEW·POWER·HOUSE·EQUIPMENT

What the Inventor and the Manufacturer are doing to save time and money in the Engine room and Power house

A Reversible Stuffing Box Wrench

The accompanying illustrations show a stuffing-box wrench, invented by August A. Friz, chief engineer of the City Brewery, St. Louis, Mo.

The wrench is adapted for use on all kinds of stuffing boxes having round screw nuts, and particularly on the stuffing-box nuts of the compressor end of vertical refrigerating machines.

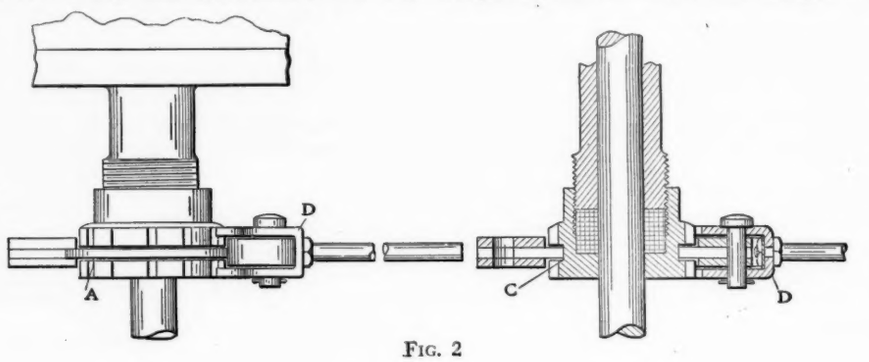


FIG. 2

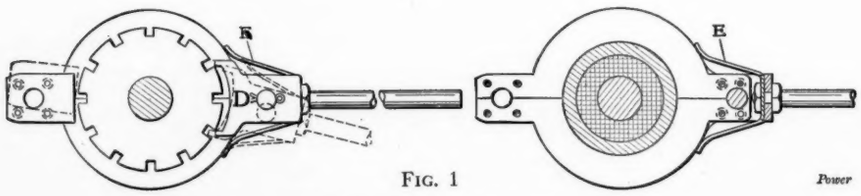


FIG. 1

APPLICATION OF REVERSIBLE STUFFING-BOX WRENCH

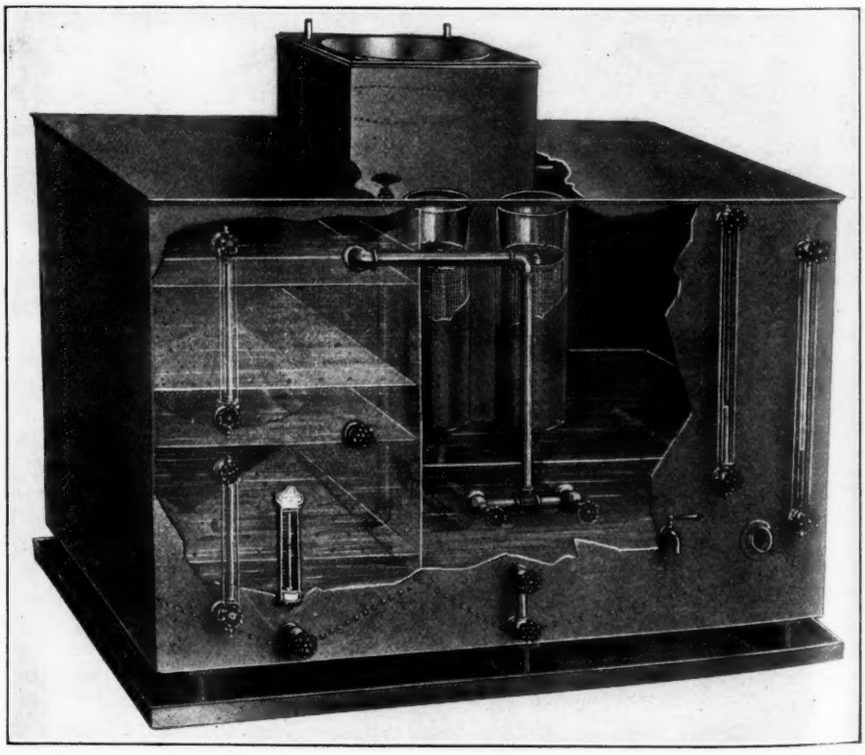
The wrench is composed of a ring *A*, Fig. 2, made in two halves, which slides in the groove *C*, generally found cut in the nut. On the ring is mounted a forked jaw *D*, having pawls which engage with the slots of the nut. A spring *E*, Fig. 2, holds the jaws with the pawls in a neutral position. A slight pressure on the lever of the wrench will engage the pawls in the first slot of the nut in whatever direction the wrench is turned. No changes or alterations are required on the machine in order to attach the wrench, and it takes but a few minutes to either connect or disconnect it.

The advantages claimed for this wrench are that it is always in position ready for use, and can be rotated in either direction, and a slight movement of the lever brings the wrench from the neutral position into action, tightening or loosening the nut as required. In cases of severe leakage of ammonia from compressor stuffing boxes, it is a simple and safe matter, not having a heavy wrench to carry, to rush to the machine, give the wrench a turn and get back to safety without having drawn a breath. The use of the usual heavy, cumbersome, portable wrench, under like conditions, is attended with grave danger.

Turner Oil Filter

The accompanying illustration and description relates to one of the designs of filters manufactured by the Turner Oil Filter Company, Niles, Mich. Referring to the illustration, oil is admitted at the top through a deep strainer pan into a cylinder, which extends to within a few inches of the bottom of its compartment. In the middle of the cylinder is a filtering bed through which the oil must pass on its downward course. A steam coil, not shown, is located immediately below the cylinder, around which the oil passes as it rises on the outside of the cylinder, to pass out of the first compartment, and down through the valve and pipe shown just below the cover, and back of the cylinder strainers. The oil enters near the bottom of the compartment shown at the left of the illustration and rising through the filtering bed and trays, passes out at the top through the pipe and valve, shown in full, lines leading to the strainer cylinder in the clean oil-storage compartment, at the right.

The vertical pipes, through which the oil enters the storage tank, extend to the bottom of both cylinders, and are clamped in position, by means of lock nuts. The outside cylinders of the strainer supports the fine-mesh brass-wire cloth by means of a flaring galvanized collar at the top and sheet-metal bottom. The pipe is placed in the center of this



SEMI-SECTIONAL VIEW OF TURNER OIL FILTER

strainer cylinder and has a reducer fitting at the top which screws over the top of the vertical inlaid pipe. To remove the strainer, it is only necessary to revolve it to the left and then take it out.

The filtering materials are held in cloth sacks or metal trays, fitted with handles by which they can be removed when necessary. The trays are filled with excelsior, which removes and holds the dirt from the oil.

Drains are provided at the bottom of each compartment, which permits of removing the dirt and water as fast as it accumulates. Gages are also attached to each compartment to show the condition of oil and hight of oil and water, while the thermometer aids in maintaining the proper temperature. The filter gages and sheet-metal parts are made of galvanized steel of heavy weight. The illustration shows the filter and drip pan, but the pan is not furnished with the regular filter except at additional cost.

The Nordberg High-Speed Corliss Valve Gear

Ranges of speed considerably higher than those formerly required of Corliss engines are now being demanded, to meet situations where it is desired to retain Corliss engine economy for electric drive and at the same time economize as much as possible on floor space. This has led the Nordberg Company to develop the design of high-speed gear shown in the accompanying photographs, and a cross-compound, vertical unit with this style of gear has lately been installed in the engine room of the Commercial National Bank building, Chicago. This unit is shown in Fig. 1, on the erecting floor, with the oil guards removed. It is noncondensing, exhausting into the heating system of the building, and drives a 300-kilowatt Western Electric generator at 150 revolutions per minute.

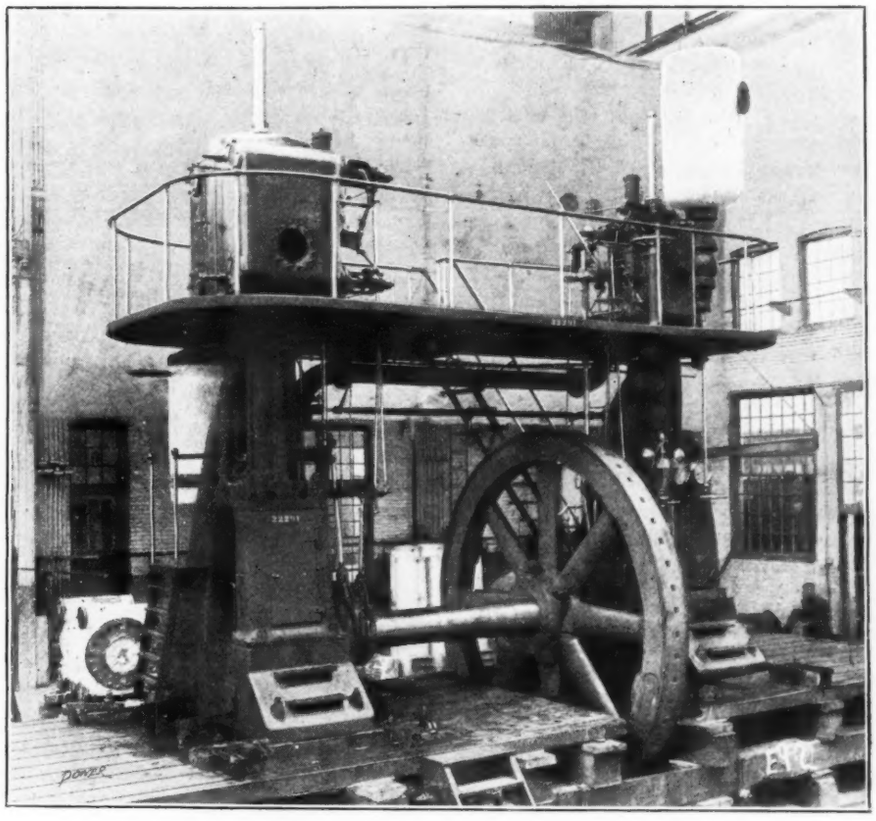


FIG. 1. NORDBERG VERTICAL HIGH-SPEED CORLISS ENGINE

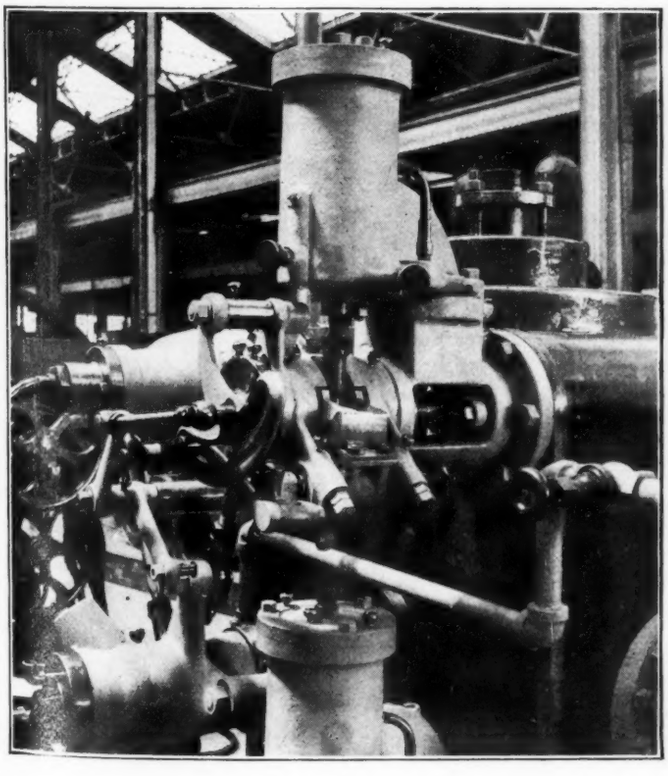


FIG. 2. STEAM VALVE GEAR AT CLOSE RANGE

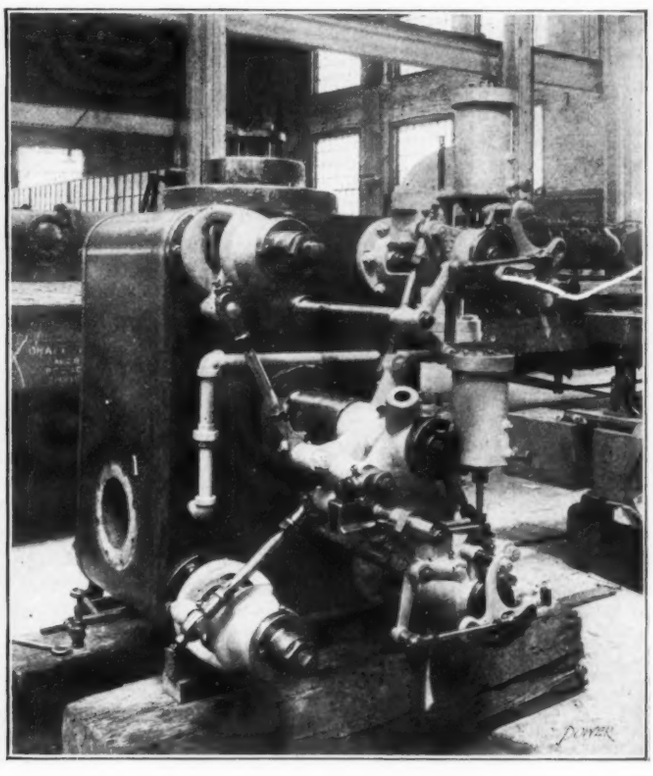


FIG. 3. LOW-PRESSURE CYLINDER

The massive vertical frames have bored guides, but are arranged for accessibility of the reciprocating parts, the lower front portion being removable to allow the placing of the shaft. The valve gear has been especially designed for high speed, with spring dashpots, small movement of parts and minimum wear on the connections. For noncondensing work one wristplate is provided, while two are used when the engine is to be run condensing. Fig. 2 shows a close view of the high-pressure steam-valve bonnet. Solidity has been attained by providing a bearing on each side of the steam arm, these bearings being as close to the cylinder as possible and yet leaving room to pack the valve stem.

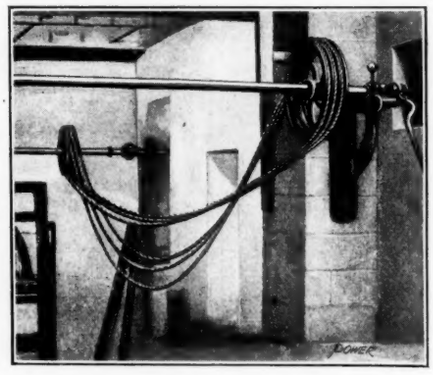
The entire valve gear is, by this construction, kept in alinement, a minimum of side strains is imposed on the bonnet, and the stuffing box is not relied on as a bearing for the valve stem. The only overhanging parts of the gear are the knock-off cam and lever which do the light work of adjusting the point of cutoff. The knock-off cam is similar to that in the standard long-range cutoff Nordberg gear, and consists of a slot having two concentric circular portions, the circles being struck from the center pivot on which the lever is hung. The trip hook is thrown in and out of engagement by means of this cam, for which purpose it is provided with a lever, the free end of which projects in front to a point opposite to the center of the valve stem, as shown, where it holds a roller fitted to the slot in the knock-off cam. The latter receives an oscillating motion from a separate eccentric on the shaft, while the central point of oscillation, and therefore the cutoff, is dertermined by the governor according to the load. As the cutoff eccentric is placed only a few degrees in advance of the crank it gives a range of cutoff up to 0.8 stroke. The fact that the requisite motion for accomplishing cutoff is independent of the rest of the valve mechanism, constitutes one of the most valuable features of the Nordberg gear, a feature which becomes especially important on full load. In all ordinary gears the steam arm itself is relied on to furnish the necessary movement to trip the valve. When the engine is taking steam at half stroke or thereabouts, the steam arms have very little motion at the instant cutoff should occur. A sluggish action may result, with consequent wire drawing and poor steam distribution, while with an independent cutoff such as is obtained with this gear, the action is fully as sharp and distinct on heavy loads as at any other portion of the stroke.

The steam valves in this design are ground to fit in reamed valve chambers and have a quadruple-ported action, the ordinary double-ported valve being combined with a construction on the principle of the Allen "Trick" valve, so that the valves are not only double-ported, but have double-ported openings at each edge. This gives an unusually short valve travel which is desirable at high speeds, and is especially advantageous where spring dashpots are used, a fairly constant tension being exerted by the spring, however slight the valve movement, as compared with the ordinary vacuum dashpot, which must have more or less travel before being able to exert any appreciable force in closing the valve. The value of this property of the spring dashpot becomes very apparent on light loads, a short distinct cutoff being secured. To cushion the closing of the valve a small air cylinder is provided, the action of which can be adjusted by a thumb screw, regulating a bypass around the piston. No vacuum action is depended on, however, in the operation of the dashpot.

Fig. 3 is a view of the low-pressure valve gear. It will be noted that each exhaust-valve bonnet carries a set screw and lock nut on the end. This is used to prevent end play and slamming of the valve when running condensing. This gear has been applied to horizontal as well as vertical engines and can be run at speeds up to 180 revolutions per minute if desired.

A Slack Rope Drive

The rope drive installed in the Paramatta Woolen Mills, Sydney, N. S. W., as shown in the illustration, is rather odd in several ways. The three ropes are independent of each other (English system), and have stretched to such lengths that their slack parts sag far below and run in between the driving sides. The ropes are said to run well in spite of the contact with each other.



SLACK ROPE DRIVE

It will also be noted that in spite of the stretch of ropes to unequal lengths, each assumes about an equal portion of the load. The equal distribution of the load is said to be made possible, in this instance, by treating the ropes with Cling-Surface, made by the Cling-Surface Company, Buffalo, N. Y.

Disposal of Power-plant Ashes

The disposal of ashes from a large power plant is an item of expense that often amounts to hundreds of dollars per year. Any device that will reduce this expense adds just that much to the dividends of the corporation.

The power plant of the Federal Lead Company, Flat River, Mo., comprises six 450-horsepower Heine boilers, five of which are in use all the time. Automatic stokers are used and 100 to 110 tons of coal consumed daily. The cinders and ashes drop into a pit below the level of the firing floor. All the pits are connected with a tunnel into which the ashes were formerly scraped and wheeled out in barrows to the ash heap. Later a cable car was installed but this did not work satisfactorily as the car would jump the track, or go over the end of the track, due to overwinding.

The scheme now in use consists of an inclined 8-inch iron trough set in the concrete floor of the tunnel, so the ashes may be scraped into it direct from the ashpit. As the ashes are dropped into this trough, water is turned in at the upper end, washing the ashes to the boot of a bucket elevator. The elevator has a 14-inch rubber belt, with a 12-inch bucket. The ashes are elevated vertically about 50 feet where they are emptied into a trough and sluiced out with water. The trough is a 12-inch water pipe split in two, and is inclined about 1½ inches per foot. This installation saves the labor of four men on each shift, or 12 men since three shifts are worked here. Thus a large saving is effected which will soon pay for the entire ash-disposal outfit.

Stevens Alumni Dinner

At the ninth annual dinner of the Alumni of Stevens Institute, which took place at the Hotel Astor, New York, on Saturday evening, February 12, nearly three hundred men enthusiastically cheered President Humphreys when he presented his program for the development of Stevens and made a plea for the money necessary to carry out his plans. The audience included a goodly number of noted men.

President Humphreys announced that he had recently received $63,500 of the $1,250,000 which he expects to raise for the improvement and extension of Stevens Institute. This money is to be used for the purchase of the Castle Point estate, for the erection of several buildings, including a dormitory, a mechanical laboratory, and an electrical laboratory, and to provide an adequate endowment fund.

What is immediately required, and what it is expected will be secured before long, is the sum of $400,000 for paying off the debt still remaining on the athletic field and for acquiring the other necessary real estate for the growing needs of the Institute.

INQUIRIES OF GENERAL INTEREST

Questions are not answered unless they are accompanied by the name and address of the inquirer

Direct-current Magnet Rewound for Alternating Current

How can a magnet made for direct current be rewound to work on alternating current?

E. F. B.

It cannot be done satisfactorily unless the magnet has laminated cores, armature, yoke, etc., which is not probable. If that should be the case, however, you can find out the proper winding by the following cut-and-try method.

Unwind a considerable portion of the wire now on the magnet—say, about one-third of it—and try the magnet with the alternating current. If it is not strong enough, unwind a little more wire and try it again. Repeat this, if necessary, until the magnet will pick up its normal load promptly.

Then unwind all of the wire remaining on the magnet and weigh it. Also weigh the wire that you had to take off to get the magnet to work. Adding these two weights will give you the total weight of the original winding, and the new winding should contain that quantity. To find the proper size of wire for the new winding, divide the total weight by the weight that was required for the magnet to work properly, and multiply the quotient by the circular mils of the wire in the old winding; the result will be the circular mils for the new wire, and a table of wire sizes will show what is the nearest standard size. For example, suppose the present winding was of No. 20 wire, and you had to take off 15 ounces of wire to get it to work on alternating current of the same voltage; also suppose this left 25 ounces of wire in the winding. No. 20 wire has 1021½ circular mils, so that the new winding would have to be of wire having

$$1021\tfrac{1}{2} \times \tfrac{40}{25} = 1634.4$$

circular mils. The nearest standard size is No. 18, having 1624.3 circular mils.

Don't forget, however, that the iron in the magnet and related parts must be laminated and the voltage must be the same as the direct-current voltage for which the magnet was originally made.

Combustion and Air

What is meant by combustion and what difference does it make in the heat that can be got from the coal whether much or little air is supplied?

J. G. B.

Combustion is the uniting of the carbon and hydrogen in the coal with oxygen from the air, which is a mechanical mixture of 79 parts of nitrogen and 21 parts of oxygen. When coal is burned the union of the hydrogen with the oxygen forms water and the union of the carbon with the oxygen forms either carbon monoxide or carbon dioxide. If sufficient air is admitted to the furnace the carbon will unite with twice its volume of oxygen and form carbon dioxide; this is termed perfect combustion, and one pound of carbon burned in this way will yield 14,500 heat units. If insufficient air is supplied the carbon will unite with the oxygen in equal proportions, that is one atom of carbon with one of oxygen, forming carbon monoxide and giving out only 4400 heat units, or less than one-third as much heat as when the proper amount of air is furnished.

In everyday work it is not practicable to regulate the supply of air to the exact amount needed for perfect combustion, and imperfect combustion is guarded against by admitting a slight excess of air, as the heat lost in heating the excess of air to the temperature of the gases going up the chimney is much less than that resulting from imperfect combustion. The excess air has to be heated to the temperature of the furnace, and does not aid combustion at all; therefore it merely carries away and wastes the heat units required to raise its temperature from that at which it enters the furnace to that at which it leaves. But as it requires less than one-quarter of a heat unit to raise the temperature of a pound of air one degree, double the amount of air required for perfect combustion would result in a loss of only about 10 per cent., while an insufficient air supply might easily mean a loss of about 70 per cent. of the heat value of the fuel.

Available Energy in Steam

In a paper read several years ago by George H. Babcock he considers an engine using steam as a gas without latent heat, in *Transactions* of American Society of Mechanical Engineers, Volume VII, page 710. He figures the efficiency of the cycle to be 28 per cent. and calls the heat expended per pound of steam (using only 28 per cent. of the absolute range) 80,674 foot-pounds. He then proceeds to take 28 per cent. of this, making the consumption of a perfect machine 87.6 pounds steam per horsepower-hour.

If said 80,674 foot-pounds is only 28 per cent. of the total energy, why should this not be all available in the engine?

In boiler tests where superheat is obtained is it usual or proper to credit boiler with all the heat shown minus the heat in the feed, or to allow only 48 per cent. of the additional heat above the temperature of the saturated steam?

A. G. H.

Mr. Babcock does not use the 28 per cent. in calculating the amount of heat expended per pound of steam. He takes the steam at a temperature of 100 degrees (460 + 100 = 560 degrees absolute) and heats it to 320 degrees (460 + 320 = 780 degrees absolute). He assumes that it takes 0.475 B.t.u. to raise one pound of this steam one degree and that one B.t.u. is equal to 772 foot-pounds, so that to raise one pound from 100 to 320 would take

$$(320 - 100) \times 0.475 \times 772 = 80{,}674$$

foot-pounds of work in the form of heat. The value now commonly accepted for the B.t.u. in foot-pounds is 778 instead of 772.

A perfect engine would convert only

$$\frac{780 - 560}{780} = 0.28$$

of this heat into mechanical work, which would make

80,674 × 0.28 = 22,588 foot-pounds.

A horsepower-hour is

33,000 × 60 = 1,980,000 foot-pounds.

If one pound of steam produces 22.588 foot-pounds it will take

1,980,000 ÷ 22,588 = 87.6 pounds

to produce a horsepower for one hour.

The 80,674 is not "28 per cent. of the total energy"; it is the total energy supplied.

It is usual to credit the boiler with all the heat put into the steam. It has been usual to multiply the weight of steam by 0.48 and by the number of degrees it is superheated because Regnault determined that it takes 0.48 of a heat unit to heat a pound of dry steam one degree, but it is now known that this is correct only for about atmospheric pressure and temperature. See Superheated Steam, by Prof. S. A. Reeve, in POWER for February 18, 1908, page 253. This would give not "48 per cent. of the additional heat above the temperature of saturated steam." but all the heat used to superheat the steam if it were a fact, as the calculation supposes, that it takes only 0.48 as much heat to raise the temperature of steam as to raise the temperature of water the same amount.

New Laboratory of Mechanical Engineering for the Sheffield Scientific School

The director of the Sheffield Scientific School, Dr. Russell H. Chittenden, has announced a gift to the Sheffield Scientific School, of Yale University, of $250,000 for the construction and equipment of a new mechanical-engineering laboratory. Two graduates of the school, of the class of 1888, George G. Mason, of New York City, and his brother William S. Mason, of Evanston, Ill., have given this money to the board of trustees of the school.

The new laboratory will have a frontage of about 85 feet, will extend back 200 feet and be four stories in hight. It will contain approximately 50,000 square feet of floor area and 880,000 cubic feet of space. The entire equipment will be new and will consist of the most modern appliances for assisting the student in studying those fundamental principles of applied science which are closely related to mechanical engineering, such as, the strength of materials, the combustion of fuel in furnaces and in internal-combustion engines, the making of steam in boilers of different types, the using of saturated and superheated steam in engines or steam turbines, the artificial production of cold, the production, transmission and use of compressed air, the pumping of water, the transmission of power, and the problems of heating and ventilation.

It is expected that the plans will be ready so that work on the laboratory may be begun by next July and the building completed and equipped by June, 1911.

SOCIETY NOTES

Robert Fulton Association No. 57, N. A. S. E., of Brooklyn, N. Y., held its annual smoker on Wednesday evening, February 9, at the meeting rooms in the Modern Science Club. There was a large attendance. The "Bunch" furnished a pleasing entertainment, and brief addresses were made by National President W. J. Reynolds, and Past National President H. E. Stone. A plentiful supply of refreshments was served at intervals.

The South African Institute of Electrical Engineers, the only society connected with the electrical profession in South Africa, has recently been formed, with headquarters at Johannesburg, Transvaal. With the promises of support already extended to it, a membership of over 500 is shortly anticipated. As it is proposed shortly to include with the *Transactions* (to be published monthly) excerpts only, from the *Transactions* of other societies and the technical press, this young society solicits the support and coöperation of the older institutions and the electrical press, in an exchange of publications.

The combined associations, N. A. S. E., of Manhattan and the Bronx, have arranged with Professor Lucke, of Columbia University, for a series of lectures. Two lectures on "Valve Gears" have already been delivered. Lectures on "Refrigeration" will be given on March 5 at 44 Broadway and Seventy-fourth street, and on March 19 at Loeffer's hall, One Hundred and Forty-eighth street and Willis avenue. On April 16 and 30 the subject will be "Measurements and Records in Steam Plants," the first lecture to be delivered at corner Sixty-seventh street and Third avenue, and the second at 307 West Fifty-fourth street.

PERSONAL

Joseph Battles wishes to announce that he is no longer affiliated with the Lawrence Machine Company, of Lawrence, Mass., in any capacity whatever, but has opened an office, room No. 905, Oliver building, 141 Milk street, Boston, where he will handle an uptodate line of centrifugal pumps, steam and gas engines, generating sets and appurtenances.

Henry G. Stott, superintendent of motive power of the Interborough Rapid Transit Company, of New York, will read a paper on the "Low Pressure Steam Turbine" before the American Society of Mechanical Engineers at the Engineers building, 29 West Thirty-ninth street, on Tuesday evening, March 8.

Industrial Engineering and *The Engineering Digest* have consolidated, with Robert Thurston Kent as managing editor and holding a controlling interest in the stock. The editor is a son of William Kent. It is his intention to continue the index to current technical literature and the condensation of important articles on engineering subjects, formerly printed in *The Engineering Digest*, and to add special features along lines of industrial engineering.

With the February number of *The Electrical Record*, Albert Spies retired from the editorship of that publication, to become the managing director of *Foundry News*, a new illustrated monthly publication devoted to the foundry arts, with offices in the Hudson Terminal, 50 Church street, New York City. *Foundry News* will make its first appearance in April.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., William G. Snow; sec., William M. Mackay, P. O. Box 1818, New York City.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 525 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Niagara Falls, Canada, May 24-27, 1910.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo. September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, January 16-21, 1911. January 16-21, 1911.

NEW INVENTIONS

STEAM, GAS AND WATER PRIME MOVERS

FLUID-PRESSURE ENGINE. Jacob P. Klein, and Adolf Friederichs, San Bernardino, Cal. 945,462.

ROTARY ENGINE. John H. Harrison, Broadway, Va. 945,525.

ELASTIC FLUID TURBINE. Francis Hodgkinson, Edgewood Park, Penn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 945,391.

WATER MOTOR. Carl Blauel, Düsseldorf-Oberkassel, Germany. 945,367.

GAS ENGINE. Warren P. Valentine, Holyoke, Mass., assignor to International Steam Pump Company, a Corporation of New Jersey. 945,297.

TURBINE. Alexander Boeckel, Oskar Grunberg, Juri Korwin-Krukovsky, and Edouard Luxembourg, St. Petersburg, Russia. 945,742.

TURBINE. William Robinson, Brooklyn, N. Y. 945,809.

TURBINE. William Robinson, Brooklyn, N. Y. 945,810.

TURBINE. William Robinson, Brooklyn, N. Y. 945,811.

TURBINE. William Robinson, Brooklyn, N. Y. 945,807.

TURBINE. William Robinson, Brooklyn, N. Y. 945,808.

ROTARY EXPLOSIVE ENGINE. Ora W. Williams and William H. Gardner, Minneapolis, Minn. 947,008.

DEVICE FOR UTILIZING TIDE WATER AS MOTIVE POWER. Stephen M. Smith, Boise, Idaho. 946,585.

ELASTIC-FLUID TURBINE. George Westinghouse, Pittsburg, Penn., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. 946,749.

GAS AND STEAM POWER GENERATOR. Eastburne E. Lamson, Salt Lake City, Utah. 947,107.

ROTARY ENGINE. Clinton Guyer, Muncy, Penn. 944,361.

ROTARY MOTOR (STEAM). Laurence P. Stevens, Los Angeles, Cal. 944,581.

TURBINE (Steam). Oliver D. H. Bentley, New York, N. Y. 944,839.

MOTOR (Water) Gottlieb Keller, New York, N. Y. 944,441.

INTERNAL-COMBUSTION ENGINE. Dalliam E. Nageborn, Detroit, Mich. 944,811.

INTERNAL-COMBUSTION ENGINE. Dallas C. Hathaway, Sheldon, Ill. 944,362.

EXPLOSIVE ENGINE. Lloyd F. Loftus, borough of Knoxville, Penn. 944,340.

VALVE GEAR for Steam Engines. Walter M. Evered, Duluth, Minn. 944,724.

FURNACES AND GAS PRODUCERS

HYDROCARBON BURNER. Clare M. Rork, Dallas, Texas, assignor to J. W. Shelton, Dallas, Texas. 946,581.

VAPORIZER-HEATING DEVICE. Alden E. Osborn, New York, N. Y. 946,806.

GAS PRODUCER. Thomas Clouston, Vancouver, British Columbia, Canada. 946,820.

STEAM-BOILER FURNACE. Ellis F. Edgar, Woodbridge, N. J. 945,840.

GAS PRODUCER. William R. Miller, Pittsburg, Penn. 947,118.

GAS PRODUCER. John C. Swindell and John A. Swindell, Pittsburg, Penn. 947,065.

PUMPS

PUMP. Charles C. Wakefield, London, England. 945,648.

CONDENSER PUMP. Pieter J. Pennings, Kiel, Germany. 945,587.

STEAM PUMP. Franz F. Nickel, East Orange, N. J., assignor to Henry R. Worthington, New York, N. Y., a Corporation of New Jersey. 945,578.

AIR PUMP. Fred S. Carver, Brooklyn, N. Y. 946,719.

STEAM VACUUM PUMP. George E. Nye, Chicago, Ill. 944,984.

ELECTRIC APPLIANCES

METHOD OF TREATING ELECTRIC-FURNACE PRODUCTS. Aldus C. Higgins and George N. Jeppson, Worcester, Mass. 944,436.

CONTROL OF ELECTRIC MOTORS. Henry A. Mavor, Mile End, Glasgow, Scotland. 944,453.

INSTRUMENT FOR LOCATING GROUNDS AND BREAKS IN ELECTRIC CIRCUITS. Matthew J. Myers, Syracuse, N. Y. 944,459.

ELECTROMAGNETIC ACCELERATOR. Charles O. Pearson, New York, and August Sundh, Yonkers, N. Y. 944,497.

ELECTROLYTIC APPARATUS. Harry H. Bates and Folger Adam, Joliet, Ill. 44,650.

INCANDESCENT LAMP. Charles H. Crutchfield, New Boston, Texas. 944,667.

ELECTRIC FURNACE for the Continuous Extraction of Zinc from Its Ores. Eugène F. Cote and Paul R. Pierron, Lyon, France. 944,774.

RHEOSTAT. Robert Head, New York, N. Y., assignor to Robert L. Watkins, New York, N. Y. 944,785.

MOTOR-CONTROL SYSTEM. Percy H. Thomas, Pittsburg, Penn. 945,006.

MOTOR-CONTROL SYSTEM. Percy H. Thomas, Pittsburg, Penn. 945,008.

STORAGE BATTERY. Thomas A. Edison, Llewellyn Park, Orange, N. J., assignor to Edison Storage Battery Company, West Orange, N. J., a Corporation of New Jersey. 946,540.

LIGHTNING ARRESTER. William R. Garton, Brooklyn, N. Y., assignor to C. J. Griffin, Montezuma, Iowa. 946,542.

RHEOSTAT. Ford W. Harris, Wilkinsburg, Penn., assignor to Westinghouse Electric and Manufacturing Co., a Corporation of Pennsylvania. 946,544.

SECTION INSULATOR FOR ELECTRIC LINES. Hall F. Hoxie, Brooklyn, N. Y., assignor by mesne assignments, to Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., a Corporation of Pennsylvania. 946,546.

INSULATOR FOR ELECTRIC LINES. Theodore Varney, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 946,623.

ELECTRIC STOVE. Herman L. Millspaugh and Frank S. Vincent, Reed City, Mich., assignors of one-third to George D. Westover, Cadillac, Mich. 946,643.

ELECTRIC SNAP SWITCH. Norman Marshall, West Newton, Mass., assignor to the Arrow Electric Company, Hartford, Conn., a Corporation of Connecticut. 946,680.

INSULATOR CLAMP. Walter G. Clark, New York, N. Y. 946,722.

ELECTRIC-FUSE HOLDER. John H. Trumbull, Plainville, Conn., assignor to the Trumbull Electric Manufacturing Company, Plainville, Conn., a Corporation of Connecticut. 946,741.

ELECTRIC VEHICLE. Frank E. Case, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 946,753.

DYNAMO-ELECTRIC MACHINE. Louis E. Underwood and Sven R. Bergman, Lynn, Mass., assignors to General Electric Company, a Corporation of New York. 946,813.

COMPOUNDING ALTERNATING-CURRENT CIRCUITS. William Stanley, Great Barrington, Mass., assignor to General Electric Company, a Corporation of New York. 946,829.

MOTOR CAR. Chas. A. Harp, Sacramento, Cal., assignor to Harp Railway Motor Car Company, a Corporation. 946,855.

SPARK PLUG. Joseph E. Schaeffer, Jr., Cleveland, Ohio, assignor toCharles W. Fennen, Cleveland, Ohio, doing business under the name of Reflex Ignition Co., Cleveland, Ohio. 946,878.

BATTERY HOLDER. Russell W. Magna, Holyoke, Mass. 946,905.

ELECTRIC CONTROLLER. Arthur C. Eastwood, Cleveland, Ohio, and John S. McKee, Pittsburg, Penn. 947,059.

MOTOR. Max R. Guttler, Welfa, near Dresden, Germany. 947,061.

SPARKING DEVICE. Isaac W. Giles, New Bedford, and Charles W. Tobey, Fairhaven, Mass. 947,155.

MISCELLANEOUS TOOLS AND APPLIANCES

LUBRICATOR. John B. Purvis and James G. Purvis, Detroit, Mich. 946,580.

COMPRESSION TESTER FOR EXPLOSIVE ENGINES. John Desmond, Chicago, Ill., assignor to William S. Potwin, Chicago, Ill. 946,661.

CARBURETER. William K. Bassford, Perth Amboy, N. J. 946,632.

PRESSURE-REGULATED GAS VALVE FOR ENGINES. Marie L. Riotte, Jersey City, N. J., administratrix of Carl C. Riotte, deceased. 946,737.

BACK-PRESSURE VALVE. Charles C. Neighbors, San Antonio, Texas. 946,684.

PIPE WRENCH. John R. Morris, Marshalltown, Iowa. 947,081.

VALVE. Joseph Rothchild, Bayonne, N. J. assignor to John Simmons, Company, New York. 946,877.

GAGE COCK. Lambert J. Bordo, Philadelphia, Penn. 947,172.

AUTOMATIC RELIEF VALVE. Ernst A. Ploeger and John Penrose, Chicago, Ill. 947,187.

STARTING EXPLOSION ENGINES. Kules E. Malivert, Paris, France, assignor of one-half to Louis Bousquet, Paris, France. 947,021.

METHOD OF AND APPARATUS FOR DETERMINING RATE OF FLOW OF STEAM AND OTHER GASES AND VAPORS. Carl C. Thomas, Madison, Wis. 946,886.

SPLASH LUBRICATION SYSTEM. Charles N. Teeter, Hagerstown, Ind. 946,923.

WATER-TUBE-BOILER ACCESSORIES. Chas. M. Clausen, Elkhart, Ind. 946,934.

HOSE COUPLING. George B. Clay, Jenkintown, Penn. 946,935.

CRUDE-OIL BURNER. Robert A. Bright, Oklahoma, Okla. 946,955.

STEAM, AIR AND WATER TRAP VALVE. Fred W. Leuthesser, Chicago, Ill. 946,970.

GROUND JOINT CONNECTION. Frederick E. Swipe, Jr., Philadelphia, Penn. 946,990.

STEAM-ENGINE VALVE. Edwin J. Armstrong, Erie, Penn. 945,000.

AUTOMATIC THROTTLE-CLOSING AND BRAKE-CONTROLLING DEVICE. Sven. T. Nelson, Halvert B. Halvorsen, and Frank A. Halleck, Chicago, Ill., assignors to Sullivan Machinery Company. 945,046.

AUTOMATIC THROTTLE-CONTROLLING DEVICE FOR ENGINES. Jos. W. Briggs, McKittrick, Cal., assignor of one-half to Fred N. Smith, McKittrick, Cal. 946,493.

VALVE AND REVERSE GEARING FOR STEAM ENGINES. Geo. J. Clark, Defiance, Ohio, assignor of one-half to Charles Pollock, Defiance, Ohio. 946,110.

VALVE GEAR. Harry S. Vincent, Ridgewood, N. J. 946,083.

SAFETY ATTACHMENT FOR HOISTING ENGINES. Augustus L. Le Grand, West Pittston, Pa. 946,236.

LUBRICATING DEVICE FOR GAS ENGINES. Fred A. Jahnke, Minneapolis, Minn., assignor to Minneapolis Motor & Truck Co., Minneapolis, Minn. 946,133.

GAS-ENGINE STARTER. George L. Odenbrett, Milwaukee, Wis. 945,245.

STARTER FOR GAS ENGINES. Frank H. Armstrong, Vulcan, Mich. 945,738.

EXHAUST SILENCER. Edwin A. Hall, Dansville, and Francis G. Hall, Jr., Newburgh, N. Y. 945,523.

REDUCING WHEEL FOR STEAM-ENGINE INDICATORS. Parley W. Craig, Ensley, Ala., assignor of one-half to Louis Erwin Baumgarten, Ensley, Ala. 945,703.

STUFFING BOX. George Strance, Reece S. Bull, and William P. Norris, Sistersville, W. Va. 946,408.

PACKING FOR STUFFING BOXES. Oscar Lingner, Dresden-Neustadt, Germany. 945,790.

METALLIC PACKING. Frank Hennebohle, Chicago, Ill. 945,458.

ROD PACKING. Edwin J. Armstrong, Erie, Penn. 946,001.

PISTON AND ROD PACKING. Adam W. France, Philadelphia, Penn., assignor to the France Packing Company, Philadelphia, Penn., a Corporation of Pennsylvania. 945,030.

PISTON-ROD PACKING. Adam W. France, Philadelphia, Penn., assignor to the France Packing Company, Philadelphia, Penn., a Corporation of Pennsylvania. 945,031.

LIQUID SEAL OR PACKING. Karl Ahlquist, Rugby, England, assignor to General Electric Company, a Corporation of New York. 945,900.

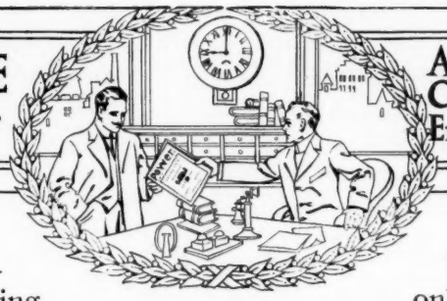
EXHAUST MUFFLER. Joseph A. Nardell and Charles A. Nardell, Utica, N. Y. 944,646.

AUTOMATIC STARTING DEVICE for Explosion Motors, etc. Eugenio Cantono, Rome, Italy. 944,316.

CARBURETER. Alexander D. Elliott, Viola, Ill. 944,482.

GAS-ENGINE STARTER. George Buress, Indianapolis, Ind. 944,315.

MOMENTS WITH THE Advertising Editor



A Department *for* Subscribers Conducted *by the* Business End *of* Power *and the* Engineer

The man who has invented a new machine will gladly spend a whole evening telling you all its wonderful points.

The fellow who has a new packing or a new boiler compound or a new baby will talk your arm off about it if you don't flag him.

But supposing he had to pay say $100 a page to talk to you—wouldn't he be tongue-tied?

You know the answer.

If he had to come across with real, "pay-to-the-order-of" money, he wouldn't shout until the new machine or article had been *tried* and *tested* and *proved* valuable *by experts*.

Then, after he really *knew* that his claims were true, he'd hire some space and tell you his little story.

Which, Mr. Reader, constitutes Reason No. 19 why *advertised goods* are safest.

* * * *

Adam Cook's Sons told us the other day that if Albany Grease was handed over the counter every time it is asked for, they would have to double the size of their factory.

Of course honest grease manufacturers have no part in the deception that allows easy substitution. They have their own distinctive cans and labels and stand on their own legs.

This, then, is the point that interests you, the consumer,—

If a concern tries to deceive you by the appearance of the goods and aims to get your business on some other firm's reputation—

If it practices deception in the *selling* of its product, what chance is there that it is honest in *manufacturing?*

If the grease was good it would not need a fake selling plan.

Substitution is an evil you must crush, for your own protection.

Insist on what you ask for —you'll get it.

* * * *

Every reader should remember that "it pays to advertise" only because *it pays to buy advertised goods.*

The rule of advertising works both ways, but it *must* work for the reader *first.*

* * * *

Advertising is a salesman. It covers more territory at far less cost than human salesmen can. It reduces the cost of marketing an article tremendously.

If it wasn't for the power of advertising, most of the things you buy would cost a whole lot more.

Bear this in mind when you read your paper.

* * * *

If P. T. Barnum hadn't lived when advertising was *in its infancy*, he would never have died a millionaire.

You can't even fool *some* of the people *some* of the time nowadays.

* * * *

And speaking of "circus advertising"—what a change time has wrought in the publicity business!

You laugh at the old-fashioned, exaggerated, superlative adjective style today—it has no effect on you at all.

Why? Simply because advertising has become a sane, practical, scientific means of promoting business.

And the few manufacturers who cling to the old circus style get more laughs than business these days.

You see it's you, the readers and buyers, who have made advertising scientific and sane.

Because you won't read unless the ad appeals to your reason, and you won't buy until you are convinced that the ad is true and the article is good.

And as a result what do you get?

Page after page of interesting, valuable, convincing information—ads full of meat, full of truth, full of reason.

And naturally you read those pages for your education and profit.

Verily, advertising has changed since the days of Barnum—and now *you* have "the greatest show on earth" of getting exactly what you want from the advertisements.